

Exploring individual-level and environmental-level influences on energy balance-related behaviors : an integrative perspective

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Exploring individual-level and environmental-level influences
on energy balance-related behaviors: An integrative
perspective

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Voor mijn lieve vader

Voor mijn lieve vader

General Introduction

GENERAL INTRODUCTION

The increasing prevalence rates of overweight and obesity (Flegal, Carroll, Kuczmarski, & Johnson, 1998; Hirasing et al., 2001; Visscher, Kromhout, & Seidell, 2002) across the globe have spurred many efforts to treat overweight and obesity. This is no surprise, since overweight and obesity are related to various medical and psychological conditions (Garrison, Higgins, & Kennel, 1996; Visscher & Seidell, 2001), impaired quality of life (Visscher et al., 2004) and have great bearing on work-related issues such as increased risk for work absenteeism (Schmier, Jones, & Halpern, 2006). Additionally, obesity impacts on the number of life-years (Peeters et al., 2003). Since treatment of overweight and obesity generally fails to yield long-term success, recent calls have been made to prevent rather than treat overweight and obesity (Carraro & Garcia Cebrian, 2003; Kremers et al., 2005a; Muller, Mast, Asbeck, Langnasa, & Grund, 2001). Prevention of obesity requires the identification of known and modifiable causes of weight gain. Although genetic factors are suggested to influence the individual susceptibility to weight gain (Kumanyika, Jeffery, Morabia, Ritenbaugh, & Antipatis, 2002), they are unlikely to be the major cause of the current obesity epidemic (Hill, 1998; Hill & Peters, 1998). The obesity epidemic can therefore not be adequately explained by biomedical models (Krantz, Grunberg, & Baum, 1985; Marteau, Dieppe, Foy, Kinmonth, & Schneiderman, 2006). Weight gain results from a positive energy-balance, which occurs when energy intake exceeds energy expenditure. Energy intake is the result of food consumption. Various biological mechanisms influence energy expenditure, such as basal metabolic rate and thermogenetic effect of food intake, but physical activity is arguably the most variable component of energy expenditure under individual control and best suited for behavioral change interventions. The increase in overweight and obesity prevalence rates is therefore largely related to behavioral factors that disrupt this energy balance. Consequently, interventions aiming to prevent weight gain should be targeted mainly at these behavioral factors, which can be referred to as energy balance-related behaviors (EBRBs) (Kremers et al., 2005a; Kremers, Visscher, Seidell, Van Mechelen, & Brug, 2005b).

Initiated by the Netherlands Heart Foundation (NHF), the multi-disciplinary research program 'Netherlands Research program weight Gain prevention (NHF-NRG)' was developed. The purpose of this program is to study determinants of weight gain and to develop and evaluate comprehensive weight gain prevention interventions for distinct target groups. Regarding the studies of weight gain determinants, two separate research trajectories were outlined. In one of the two trajectories, behavioral determinants of weight gain were investigated. More specifically, studies conducted in this trajectory

focused on identifying relevant diet and physical activity related behaviors that may either induce or prevent weight gain. In the second trajectory, psychological and environmental determinants of those inducing or preventive behaviors were studied. The results of the studies in this latter trajectory are presented in this thesis. The NHF-NRG group acknowledged the following different target groups: (1) children in primary school (age 6 – 11 years), (2) adolescents in secondary schools (aged 12-16 years), (3) young adults at workplace (aged 20 – 40 years), and (4) recently retired people (aged 55 – 65 years). Since most weight gain prevention programs to date have targeted the first age group and the expertise and data of the NHF-NRG group were mainly available for the adolescents, young adults, and elderly, it was decided to target these latter three age groups in the NHF-NRG (Kremers et al., 2005a).

Weight gain has been associated with various specific behaviors related to diet and physical activity. These behaviors include an energy-dense, high-fat and low-fiber diet, consumption of sugar-containing soft drinks, large portion sizes, and sedentary behavior such as TV-viewing (Hill, Wyatt, & McIlan, 2000; James, Thomas, Cavan, & Kerr, 2004; Ludwig, Peterson, & Gortmaker, 2001a, 2001b; World Health Organization, 2003). In contrast, regular physical activity and consumption of a high-fiber diet (for instance, a diet high in fruits and vegetables) may protect against weight gain (World Health Organization, 2003). In order to inform effective weight-gain prevention interventions, the main and modifiable determinants of these behaviors need to be identified (Green & Kreuter, 1990). Interventions then target these determinants in order to change them in a more healthy direction, which should subsequently lead to desired changes in health behavioral outcomes.

Determinant research in health education has traditionally been based on social-cognitive theoretical models that focus on identifying individual-level behavioral determinants, such as attitudes and motivations towards a particular behavior. Interventions aimed at changing those individual-level factors in a more healthy direction have generally targeted increased knowledge and awareness using educational and informational strategies, often transferred through mass media campaigns in various settings. Nevertheless, the impact of such individual interventions is often short-lived, arguably because the physical and social environments people live in do not support long-term behavioral changes once exposure to the intervention is over (Booth et al., 2000; Brownell, Stunkard, & Albaum, 1980; Gauvin, Levesque, & Richard, 2001).

The influences of these living environments or so-called ecologies (Bronfenbrenner, 1992) on human health behavior have been documented for some time

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and include both physical (e.g., access to walking spaces) and social (e.g., family climate) influences (Leventhal & Brooks-Gun, 2000). In accordance, social ecological models have increasingly been adopted in health promotion to gain a better understanding of the relative influences of social and physical-environmental factors on diet and physical activity. The application of such models requires the decision whether to directly target individuals, their environments, or both (Booth et al., 2001; Cohen, Scribner, & Farley 2000). However, the majority of health educational and promotional programs to date have been designed with a focus on individuals rather than on environments. Nevertheless, if health behavioral choices of contemporary humans are to be understood, environmental forces should not be ignored (Spence & Lee, 2003). Because health behavior research is in need for a theory that addresses the relationships between modifiable aspects of the environment and health behavior (Jeffery, 2004), progress in understanding human health behavior is perhaps best served by supplementing existing theories with creative thinking (Bauman, Sallis, Dzewaltowski, & Owen, 2002), for instance by combining the individual-oriented social-cognitive models with the environmental perspective used in ecological models (De Bruijn et al., 2006, Satariano & McAuley, 2003). One of the purposes of the present thesis is just that.

While practical and theoretical insight may be gained through theory-based modeling of environmental-level and individual-level factors with EBRBs, the social-cognitive perspective has been subjected to critique over the past decades (Bargh & Chartrand, 1999; Jeffery, 2004; Liska, 1984; Ogden, 2003). An additional purpose of this thesis was to explore potentially important additional individual-level factors that are not (yet) recognized in mainstream health behavior theories.

This introductory chapter commences by elaborating on the Theory of Planned Behavior (TPB), arguably the leading theory for explaining motivational influences on human health behavior. The key variables of this theory are described, as well as the postulated relations between environmental-level and individual-level variables. Next, ecological models of health behavior are described and the usefulness of an integrative view is outlined, followed by a more detailed description of the critiques on the TPB and the potential relevance of considering additional individual-level influences on EBRBs. Finally, this chapter ends with the overall goals of this thesis and presents an outline of the studies conducted.

THE THEORY OF PLANNED BEHAVIOR

The Theory of Planned Behavior (Ajzen, 1991) originated in the Theory of Reasoned

Action (TRA), developed by Fishbein and Ajzen in the 1970s (Ajzen & Fishbein, 1980; Fishbein & Ajzen, 1975). The TRA was originally developed to account for attitude-behavior inconsistencies, which had been an issue in social sciences since the 1930s. The concept of attitude is probably the most influential and widely-used in social psychology (Ajzen, 2002b) and its key function is guidance of behavior (Ronis, Yates, & Kirscht, 1989). Attitude refers to the evaluative dimension of a particular object of behavior and is generally assessed on semantic differential scales using bipolar adjectives, such as good-bad, pleasant-unpleasant, and harmful-beneficial (Ajzen, 2001; Conner & Sparks, 1996). According to the TRA, attitudes do not directly affect behavior. Instead, attitudes lead to the formation of a behavioral intention, which reflects one's immediate behavioral orientation towards the execution of a particular behavior. Intention thus refers to a motivational state. The TRA also identifies subjective norms as antecedents of intention. Subjective norms reflect behavioral expectations of significant others in the social environment, weighted by the motivation to conform to these expectations. As a general rule, the more positive one's attitude and the more subjective norm one perceives towards a particular behavior, the stronger one's intention is to perform this behavior. Meta-analytic reviews provide adequate support for the intention-behavior relationship (Randall & Wolf, 1994; Sheppard, Hartwick, & Warshaw, 1988).

Behavioral intention is posited to be a necessary cause of behavior; however, it is not a sufficient one. The effect of intention upon behavior is contingent upon, amongst others (such as scale correspondence), the volitional nature of that behavior. According to the TRA (Fishbein & Ajzen, 1975), intentions only predict behaviors that are under complete volitional control, i.e. behaviors that are not dependent upon environmental opportunities or lack of personal abilities and skills. Consequently, performance of the theory was found to be poor for behaviors in which people do not have complete volitional control (Sheppard, Hartwick, & Warshaw, 1988). Thus, lacking perception of control may prevent the formation of a positive intention, even though attitude and subjective norm may be favorable. In order to take account of this limitation, the TRA was extended with a third element - the concept of perceived behavioral control (PBC). PBC refers to one's perceptions of the degree to which performance of behavior is up to oneself. Measures of PBC are designed to capture the perceived facilitating and inhibiting effects of all accessible control factors, generally assessed using bipolar adjectives, such as easy-difficult and able-unable regarding the behavior under study (Ajzen, 2002a). With the inclusion of PBC, the Theory of Reasoned Action was renamed into the Theory of Planned Behavior (TPB) (Ajzen, 1985; 1991). PBC is thought to influence behavior in two

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ways. First, PBC influences behavior through its effect on intention. In this case, PBC influences behavior indirectly. Second, when people are realistic about their judgment of a behavior's difficulty, PBC serves as a proxy of actual control and thus influences behavior directly (Ajzen & Madden, 1986; Ajzen, 2002a).

The TPB is assumed to be a comprehensive and parsimonious model for explaining and predicting health behavior (Ajzen & Fishbein, 1980), yet one particular concern is its apparent disregard for influences that stem from the physical and social environment. The importance of such environmental influences is, however, not denied. Rather, they are regarded as distal factors. The TPB posits that distal factors influence behavior indirectly, i.e. they affect behavior only through their influence on intention and/or PBC. For instance, increased availability of fruits may result in a more positive attitude towards fruit consumption, while poor availability of exercise opportunities may lead to decreased perception of controllability regarding exercise behavior. However, the TPB does not delineate how these distal variables affect the more proximal factors and is, therefore, a theory of the most proximal causes of behavior (Aarts, Paulussen, & Schaalma, 1997). Figure 1 provides a visual representation of the proposed relations in the TPB.

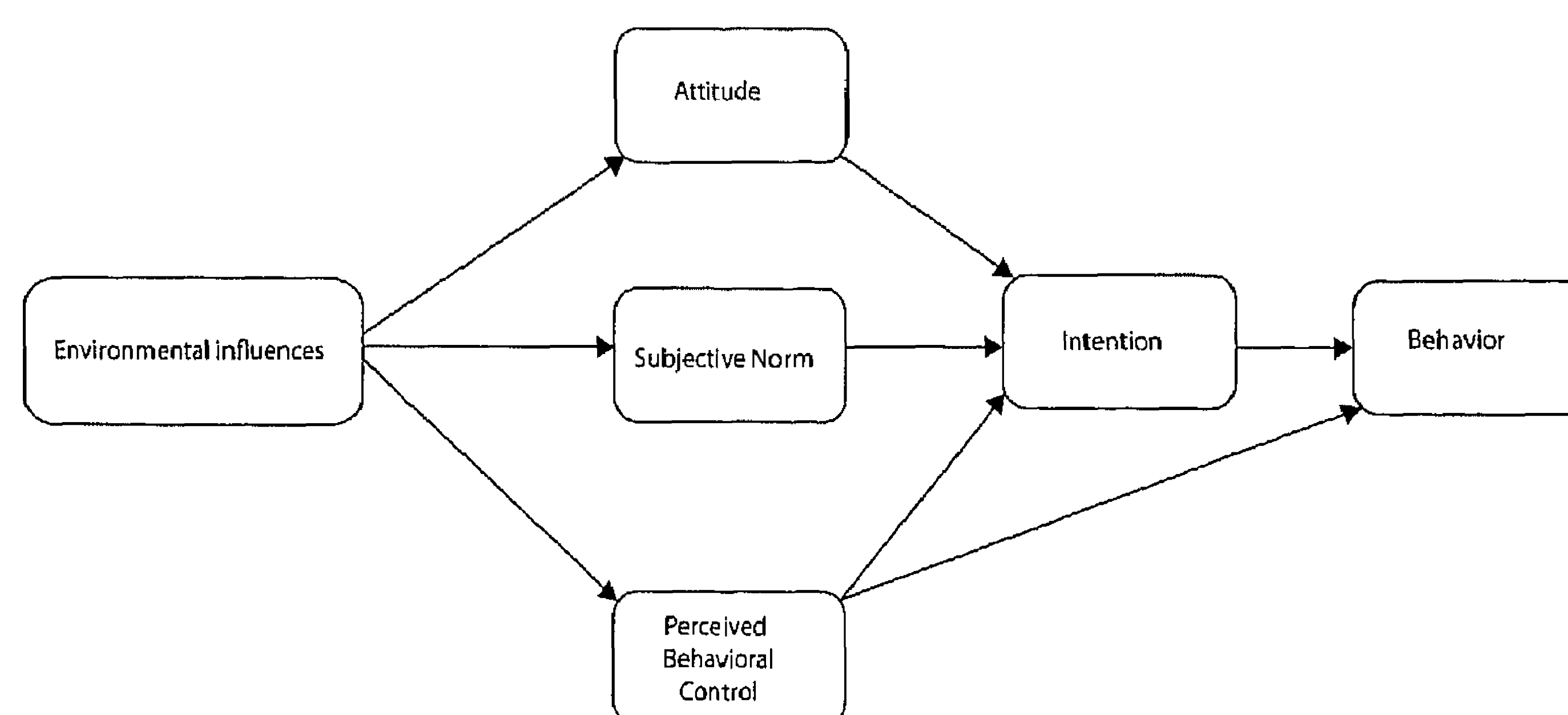


Figure 1. Theorized relations in the Theory of Planned Behavior

The TPB has been used extensively in the identification of determinants of a wide range of behaviors, including EBRBs (Bamberg, Ajzen, & Schmidt, 2003; Blanchard, Courneya, Rodgers, Daub, & Knapik, 2002; Bogers, Brug, Van Assema, & Dagnelie, 2004; Brug, Lechner, & De Vries, 1995; Conner, Norman, & Bell, 2002; Courneya & McAuley, 1993; Kassem & Lee, 2004). Quantitative reviews and meta-analyses provide support for its use in understanding EBRBs (Godin & Kok, 1996; Hagger, Chatzisarantis, & Biddle, 2002). For instance, in a review of 56 studies, including 58 behaviors such as exercising, using condoms, brushing teeth, and fruit and vegetable consumption, Godin and Kok (1996) found that attitude, subjective norm and perceived behavioral control accounted for, on average, 41 percent of the variance in intention. Furthermore, their review showed that attitude, subjective norm, perceived behavioral control and intention were able to explain, on average, 34 percent of the variance in behavior. Similar results were reported in a review of the TPB by Sutton (1998). A recent meta-analysis of the TPB in the physical activity domain (Hagger, Chatzisarantis, & Biddle, 2002) showed that the model was able to explain some 28 percent in physical activity behavior.

SOCIAL ECOLOGICAL MODELS

Although the health promotion research field is relatively young, the ecological perspective of health behavior has been central to public health concepts and methods since the nineteenth century (Green, Richard, & Potvin, 1996). The term 'human ecology' was first introduced by Park, Burgess and McKenzie in the 1920s, who attempted to apply a basic theoretical scheme of plant and animal ecology to the study of human communities (Green, Richard, & Potvin, 1996; Park, Burgess, & McKenzie, 1925). In a broad sense, ecology refers to the interrelations between organisms and the environments they inhabit (Hawley, 1950). Because of its behaviorist roots, the ecological perspective posits that environmental factors may influence health behavior directly (i.e. unmediated by individual factors such as those proposed in the TPB) (Sallis, Johnson, Calfas, Caparosa, & Nichols, 1997; Spence & Lee, 2003). The present-day environment people live in has often been emphasized as an important cause of the obesity epidemic and Egger and Swinburn (1997) summarized that obesity is a normal response to an abnormal environment, rather than vice versa. This abnormal environment has frequently been dubbed 'an obesogenic environment' (Egger & Swinburn, 1997; Swinburn, Egger, & Raza, 1999; World Health Organization, 2003). Health promotion has endorsed the importance of environmental influences for quite some time, with environmental

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interventions playing a mayor role in many public health successes (Sallis, Bauman, & Pratt, 1998). Indeed, as noted by Egger and Swinburn (1997), "*historically, epidemics have been controlled only after environmental factors have been modified*" (p.480). Examples of this notion include improved sanitary conditions (preventing outbreak of cholera in the 19th century), the fluoridation of drinking water (dramatically declining dental caries prevalence rates in the second half of the 20th century), and installing safety devices in automobiles (reducing risk of driver injury from car accidents).

With the current increase in unhealthy lifestyles and the presumed importance of the obesogenic environment in the current obesity epidemic, it should come as no surprise that health promotion has embraced the ecological framework. In the definition of Green and Kreuter (1990), "*health promotion is a combination of educational and environmental supports for actions and conditions of living conducive to health*" (pp. 221). Nevertheless, the environmental perspective has not yet received the same degree of scientific attention in weight-gain prevention efforts as the individual perspective, presumably because the processes through which environmental factors influence EBRBs have not been clearly delineated (Baranowski, Cullen, Nicklas, Thompson, & Baranowski, 2003).

Another reason for this lack of attention may be attributed to the inherent complexity of ecological models. Virtually all definitions emphasize various types of environmental influences at multiple levels of influence (Bronfenbrenner, 1977a, 1977b; McLeroy, Bibeau, Steckler, & Glanz, 1988), such as environmental contingencies, social networks, familial relations and economic trends, underlining a strong need to dissect the obesogenic environment. One framework that may be of particular relevance for disentangling the numerous potential obesogenic environmental influences has been developed by Swinburn, Egger and Raza (1999). Their ANGELO (Analysis Grid for Environments Linked to Obesity) framework has evolved from an ecological perspective and was developed specifically to conceptualize the obesogenic environment in order to identify potential areas that could be successfully targeted in interventions. Although this framework is thought to be most valuable for needs analysis and problem identification (Swinburn, Egger and Raza, 1999), it may also serve as a useful tool for dissecting environmental influences in determinant research. The ANGELO-grid is shown in Figure 2.

	Micro-level	Macro-level
Physical environment		
Political environment		
Socio-cultural environment		
Economical environment		

Figure 2. Types and levels of influence in the ANGELO-grid

In brief, the ANGELO framework recognizes four types of the environment and two levels of influence. The types refer to what is available (physical), what are the costs (economic), what are the rules (political) and what is the social and cultural background (socio-cultural), whereas the levels are divided into micro-level and macro-level influences. Individuals interact with the environment in multiple micro-environmental settings, including schools, workplaces, homes and neighborhoods, which are in turn influenced by the broader macro-environments, which includes for example health systems, governments and the food industry. The application of the ANGELO-framework has proven useful to categorize environmental interventions aiming to improve physical activity and dietary behaviors, as well as current efforts in the field of environmental determinants of these behaviors (Brug & Van Lenthe, 2005).

With regard to these environmental determinants, evidence suggests positive associations between physical environmental factors and EBRBs. For instance, Humpel and colleagues (2004) and Owen and colleagues (2004) found positive associations between aesthetically pleasing environments and walking, while Duncan, Spence and Mummery (2005) reported positive associations between presence of PA facilities with activity behaviors. Similarly, positive associations have been reported for the nutrition physical environment, such as the availability of fruit and vegetables and soft drink vending machines (Bell & Swinburn, 2004; French, Story, & Fulkerson, 2003; French & Wechsler, 2004; Grimm, Harnack, & Story 2004; Van der Horst et al., in press). In addition to such physical environmental influences, factors from the social environment have frequently been found to be positively associated with EBRBs. For instance, substantial evidence links social support with physical activity in various age-groups (Courneya, Plotnikoff, Hotz, & Birkett, 2000; De Bourdeauhuij & Sallis, 2002; Duncan, Duncan, & Strycker, 2005; Ferreira et al., in press; Stahl et al., 2001). Additionally, parents are known to be one of the most influential social-environmental factors for adolescents (Baranowski, 1997).

INTEGRATION

From the above, it is clear that environmental-oriented interventions as an adjunct to individual-oriented interventions may have potential for weight-gain prevention. Efforts to promote weight-gain preventive and to discourage weight-gain promotive behaviors should be based on a sound understanding and a clear theoretical account of the ways in which relevant environmental determinants influence EBRBs and their related social-cognitive factors. Even though the application of theory should improve the likelihood of the effectiveness of interventions (Brug, Oenema, & Ferreira, 2005), the evidence regarding environmental determinants of EBRBs has often been the result of non-theoretical approaches (Owen, Humpel, Leslie, Bauman, & Sallis, 2004). While ecological models have much to offer for obesity prevention (Baranowski, Cullen, Nicklas, Thompson, & Baranowski, 2003), there are significant conceptual and methodological challenges in identifying how the environmental factors outlined in ecological models might influence EBRBs (Owen, Humpel, Leslie, Bauman, & Sallis, 2004). As argued by Baranowski (2003), "*more conceptually refined models of how environments might affect behavior are necessary, such as whether they affect behavior directly or through as yet unspecified mediating variables*" (p.33). Since ecological model usually do not include informational and motivational variables (Baranowski, Cullen, Nicklas, Thompson, & Baranowski, 2003), practical and theoretical progress in understanding EBRBs may benefit from combining the broad environmental perspective used in ecological models with the individual-level motivational perspective used in the TPB. Importantly, the TPB proposes theoretically plausible and empirically verifiable ways through which ecological factors in the environment operate to influence EBRBs (see Figure 1). The notion of an integrated model is not new, with several comprehensive environment-health behavior models being proposed in recent years (Foster & Hillsdon, 2004; Glanz, Sallis, Saelens, & Frank, 2005; Pikora, Giles-Corti, Bull, Jamrozik, & Donovan, 2003; Spence & Lee, 2003). However, what is missing is a set of observational studies testing such an integrated model (Foster & Hillsdon, 2004). This thesis therefore attempts to add to the current knowledge in the weight-gain prevention field by presenting the results from a series of studies that have explored the relative influences of environmental and personal factors on EBRBs.

ADDITIONAL INDIVIDUAL-LEVEL INFLUENCES

Although practical and theoretical insight may be gained from disentangling the numerous influences from the environment and modeling these environmental factors

with action-specific social-cognitive TPB-variables, the reasoned action perspective of the TPB has been subject to some critique (Bargh & Chartrand, 1999; Jeffery, 2004; Liska, 1984; Ogden, 2003). For instance, Sutton (1998) noted that, despite the theorized comprehensive nature of the TPB, much of the variance in behavior remains unexplained. Indeed, both quantitative and qualitative reviews (Armitage and Conner, 2001; Godin, 1993; Godin & Kok, 1996; Hagger, Chatzisarantis, & Biddle, 2002) indicate that the TPB explains at best 40 percent variance, leaving more than half of the variance unexplained. Additionally, Ogden (2003) criticized, amongst other social-cognitive models, the TPB and emphasized that *"all data can be used to indicate the strength of a social cognition model, but (...) no data can be collected to show that it is wrong. They therefore cannot be tested."* (pp. 425). Likewise, Jeffery (2004) noted that *"information about people's cognitive processes adds little to our ability to predict the results of interventions"* (pp. 4). Although all critics agree that the concepts and assumptions of social-cognition theories should not yet be abandoned, the limited predictiveness of the existing theoretical models does leave substantial room for improvement. Therefore, major contributions to understanding health behavior should come from critical tests of the assumptions posited in those theories and extending the existing models with new variables (Baranowski, Cullen, Nicklas, Thompson, & Baranowski, 2003). In line with those critiques, this thesis explored several potential issues that may further our understanding of health behavior. The usefulness of exploring these issues is described below.

First, while one line of research has focused on decision-making and information processing that are implicated in the choice to engage in EBRBs, another line of research has focused on individual differences in personality (Caspi et al., 1997). The search for individual personality differences and their relations with EBRBs may be useful to explore for several reasons. One of these reasons concerns the so-called lack of temporal stability of social cognitions (Conner, Sheeran, Norman, & Armitage, 2000; Rhodes, Courneya, & Jones, 2004; Sheeran & Abraham, 2003). Temporal stability refers to the extent to which factors remain unchanged over time, regardless whether or not they are challenged (Sheeran, Orbell, & Trafimow, 1999). Empirical evidence has demonstrated that social cognitions fluctuate across small time-spans. For instance, in a study amongst undergraduate students, Courneya and McAuley (1993) found that the correlation between 'short-range' intention towards physical activity and the corresponding behavior three days later was .43, indicating that intention was only able to account for 18 percent of the variance in physical activity half a week later. Contrasting the temporal instability

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of cognitions, personality refers to individual tendencies to behave, think, and feel in certain consistent ways that are stable over time and situation (Caspi et al., 1997; Kendrick & Funder, 1988). With regard to personality research, the Big Five has been the most commonly used framework in the last two decades (Costa & McCrae, 1985; 1990). This framework distinguishes the following five dimensions: Extraversion, Conscientiousness, Agreeableness, Openness to Experience and Emotional Stability. These dimensions are described in more detail in Chapter 7 and are found irrespective of factor analytical techniques (Goldberg, 1990), method of assessment (McCrae & John, 1992) and they appear universal across cultures (Jang, McCrae, Angleitner, Riemann, & Livesley, 1998). Although these dimensions have also been identified in adolescents (Scholte, Van Aken, & Van Lieshout, 1997), studies focusing on associations between the Big Five personality dimensions and health behaviors have primarily been conducted in (young) adults (Booth-Kewley & Vickers, 1994; Courneya, Bobick, & Schinke, 1999; Courneya & Hellsten, 1998; Lemos Giraldez & Fidalgo Aliste, 1997; Rhodes & Courneya, 2003; Rhodes, Courneya, & Jones, 2002; 2004). Findings from these studies suggest that combining broad personality dimensions and specific cognitions may provide a more sufficient account of the determinants of behavior (Conner & Abraham, 2001).

Second, Hill (2000) argued that no single factor can be identified as a universal causal factor in the current obesity epidemic with many behaviors exerting pressure towards a positive energy balance. However, health education to date has focused primarily on changing single health behavior and very few studies have investigated the process underlying behavioral change when more than one behavior needs to be modified (King, Marcus, Pinto, Emmons, & Abrams, 1996). This is partly due to theories such as the TPB, which force researchers to isolate behaviors in order to increase explanatory value of the studied determinants (Ajzen & Fishbein, 1980). However, findings from epidemiology demonstrate that several EBRBs are associated. For instance, physical activity has been found to be positively associated with fruit and vegetable consumption (Johnson, Nichols, Sallis, Calfas, & Howell, 1998; Schuit, Van Loon, Tijhuis, & Ocke, 2002) and a prudent diet (Raitakari et al., 1994). Likewise, Kremers, Van der Horst, and Brug (in press) found positive medium effect sized correlations between screen-viewing behaviors and consumption of sugar-sweetened beverages. When a combination of behaviors is more prevalent than one would expect on the prevalence of the separate behaviors, this co-occurrence is labeled as clustering in the epidemiological research field (Schuit, Van Loon, Tijhuis, & Ocke, 2002). Clustering of energy balance-related behaviors may therefore require a combined investigation of their behavioral determinants

(Kremers et al., 2005b), but evidence from clustering studies in adolescents is lacking.

Finally, although intention is theorized to be the primary determinant of health behavior, several lines of research suggest this intentional control to be more limited than the TPB assumes (Sheeran, 2002). For instance, when a measure of past behavior is included in a regression equation, the effect on intention on behavior tends to diminish or even disappear. However, past behavior is often denoted as an empty construct (e.g. Eagly & Chaiken, 1993) and, importantly, cannot be altered through behavior-change interventions. Therefore, past behavior is of little practical interest to health education and promotion. One of the mechanisms that may account for the direct association between past and current behavior is habit (Aarts, Verplanken & Knippenberg, 1998). According to Triandis (1977, 1980), behaviors that are guided by strong habits are under less intentional control. Habit may therefore play a moderating role in the intention-behavior relationship and a recently developed script-based measure, the so-called Self-Report Habit Index (Verplanken & Orbell, 2003), may be a useful tool to assess the habitual nature of behaviors. However, studies using this index to investigate the potential interaction effect of habit in the intention-behavior relationship are unavailable to date.

DATASETS

Several datasets were used in the studies conducted as part of this thesis. Chapter 2 used data from the Longitudinal Aging Study Amsterdam (LASA), an ongoing multi-disciplinary longitudinal study of predictors and consequences of changes in autonomy and well being in the aging population with an over-sampling of men and older-old people. Chapter 3 and 8 used data from a 1997 cross-sectional sample, collected by the Netherlands Heart Foundation. In Chapter 4, 5, and 7, data from the Study on Medical Information and Lifestyles in Eindhoven (SMILE), a recently started longitudinal cohort study, were used. Data for Chapter 6 were available from the 1996/1997 data collection of the Amsterdam Growth And Health Longitudinal Study (AGAHLS), while Chapter 9 used data from a larger longitudinal cohort study in a random sample of a Dutch internet panel (see De Vet, De Nooijer, De Vries, & Brug, 2005).

Although the environmental variables studied in this thesis were readily available, rather than carefully selected a priori, a recent review (Brug & Van Lenthe, 2005) indicated the importance of the environmental factors studied in the following chapters. Furthermore, these environmental factors were related to the micro-environment (see Figure 2). The available data did not allow us to explore environmental factors related to the macro-environment, but micro-environmental influences may be better modifiable

General Introduction

and therefore of more interest to health promotion. Furthermore, the available data were largely cross-sectional, meaning we were unable to explore and model changes in environmental factors with changes in behaviors and behavior-specific cognitions.

OUTLINE OF THE THESIS

The present thesis is divided into several parts. The first part of the thesis explores the relations between the physical environment and EBRBs. In Chapter 2, differences in crime rates, household density, walking, cycling, BMI and relative risk for obesity between low and high socio-economic status neighbourhoods are explored. Next, Chapter 3 explores the mediating role of bicycle-use cognitions in the relationship between physical environmental influences and bicycle use. In Chapter 4, a conceptual structural model is tested that integrates past physical activity, social cognitions related to physical activity and environmental-level influences with adolescent physical activity.

In the second part of the thesis, two studies are presented that focus on social-environmental factors. Chapter 5 explores the mediating effect of behavior-specific social cognitions in the parenting practices – adolescent soft drink consumption relationship and the potential moderator role of adolescent personality regarding this relationship, using data from the SMILE-study. In Chapter 6, sources and types of social support and their associations with adult moderate and vigorous physical activity are tested using a structural equation approach.

In the third part of this thesis, the role of several additional individual-level factors is explored. Chapter 7 explores the direct associations between Big Five personality dimensions with fruit and vegetable consumption, and physical activity in a sample of Dutch adolescents taking part in the SMILE cohort-study. Using cohort studies in the study of personality-related health behaviors is needed, because most previous studies of personality-health relations in adolescence have relied on school-based samples (Caspi et al., 1997). Clustering of EBRBs and their behavior-specific cognitions are explored in Chapter 8. The potentially important moderating role of habit strength in the intention-behavior relationship regarding fruit consumption is investigated in Chapter 9. The general discussion (Chapter 10) then summarizes the most important findings of this thesis, discusses methodological issues, outlines the practical and theoretical implications of the findings and ends with an integrated dual-process framework that was derived (amongst other empirical findings) from the studies described in this thesis.

Part One

Physical Environmental Influences

Chapter 2

Associations between neighborhood characteristics, walking and cycling,
and obesity in a Dutch elderly population: Results from the Longitudinal
Aging Study Amsterdam

Based on: G.J. de Bruijn, S.P.J. Kremers, T.L.S. Visscher, D.J.H. Deeg, M. Visser, G.C.F. Thomese, W. van
Mechelen, and J. Brug, (submitted)

ABSTRACT

Objective: Empirical evidence links neighborhood deprivation with an increased odds for obesity. However, the mechanisms responsible for these associations remain to be explored. In this study, we explored the associations between neighborhood socio-economic status, crime rates and household density, walking and cycling, and obesity.

Subjects: 470 participants in the Longitudinal Aging Study Amsterdam (age: 63-70y; mean age: 66.49 (SD= 2.26); 230 men)

Methods: Neighborhood status was derived from Statistics Netherlands, based on the four-digit postal code of the participant. Body height and weight were assessed using a stadiometer and calibrated weight scale, respectively. Walking and cycling were assessed in a face-to-face interview, while crime rates were assessed using data from police reports. Household density was assessed by the address density of the participant's surrounding area. Regression analyses and analyses of variance were conducted.

Results: After adjusting for age, personal income level and personal educational level, high socio-economic neighborhood status was associated with an decreased risk for obesity in males (odds ratio = .38, 95% CI = .17 - .85), but not in females (odds ratio = 1.09, 95% CI = .62-1.90). Men residing in high socio-economic status neighborhoods cycled more than males residing in low socio-economic status neighborhoods (19.18 vs. 11.42 minutes per day, $p = .039$). More crime was reported in low socio-economic status neighborhoods (29.81 vs. 14.67, $p < .001$). Crime rates were positively related to BMI ($\beta = .321$, $p < .001$) and negatively associated with cycling ($\beta = -.220$, $p = .023$) among men living in low socio-economic status neighborhoods. Among these men, more cycling was associated with lower BMI ($\beta = -.276$, $p = .004$), but cycling only partially mediated the influence of crime on BMI.

Conclusion: Increased risks for obesity amongst elderly males in deprived neighborhoods may be partly attributed higher crime rates, which are related to less cycling and higher BMI. Interventions aiming to prevent obesity in older people may need to be specifically targeted at increasing bicycle use.

INTRODUCTION

Obesity prevalence rates have increased worldwide in recent decades (Flegal, Carroll, Kuczmarski, & Johnson, 1998; Ogden et al., 2006; Seidell, Verschuren, and Kromhout, 1995; Sundquist, Qvist, Johansson, & Sundquist, 2004) and represent a major public health problem due to its link with an increased risk of mortality, chronic morbidities such as type 2 diabetes mellitus and coronary heart disease (Flegal, 2000; Garrison, Higgins, & Kannel, 1996), reduced life-expectancy (Peeters et al., 2003) and an increased number of unhealthy life-years (Visseher et al., 2004). Absolute risk for disease associated with obesity is highest in the elderly (Seidell & Visseher, 2005) and, although genetic factors are thought to influence the individual susceptibility to obesity (Kumanyika, Jeffery, Morabia, Ritenbaugh, & Antipatis, 2002), environmental and behavioral factors are arguably of greater importance to the current obesity epidemic (Hill, Wyatt, & Melanson, 2000). Weight gain occurs when energy intake exceeds energy expenditure over a period of time, leading to a positive energy balance.

Environmental factors, such as neighborhood deprivation, have been found to be positively associated with overweight prevalence rates (Ellaway, Anderson, & Macintyre, 1997; Van Lenthe & Mackenbach, 2002). Additionally, a large body of evidence links specific neighborhood factors, such as household density, crime rates and aesthetics, with physical activity (Booth, Owen, Bauman, Clavisi, & Leslie, 2000; Brug & Van Lenthe, 2005; Foster & Hillsdon, 2004; Humpel, Owen, Iverson, Leslie, & Bauman, 2004; Li et al., 2005; Li, Fisher, Brownson, & Bosworth, 2004). Consequently, these specific neighborhood factors may differ between deprived and non-deprived neighborhoods, which, in turn, may be related with differences in physical activity levels. These differences in physical activity levels may subsequently be associated with differences in BMI and obesity. Although such a causal model remains to be explored (Diez-Roux et al., 1997), Van Lenthe and Mackenbach (2002) suggested a conceptual model linking neighborhood deprivation with differences in specific neighborhood factors and subsequent differences in physical activity and overweight (see Figure 3). Based on this framework, the aim of the present study was twofold. First, we investigated differences in obesity prevalence rates, crime rates and household density between low and high socio-economic status neighborhoods using objective measurements. Second, we explored the associations between crime rates and household density with BMI and the potential mediating role of walking and cycling, since these activities are typically done in neighborhoods by elderly (Bauman, Sallis, & Owen, 2002; Li et al., 2005).

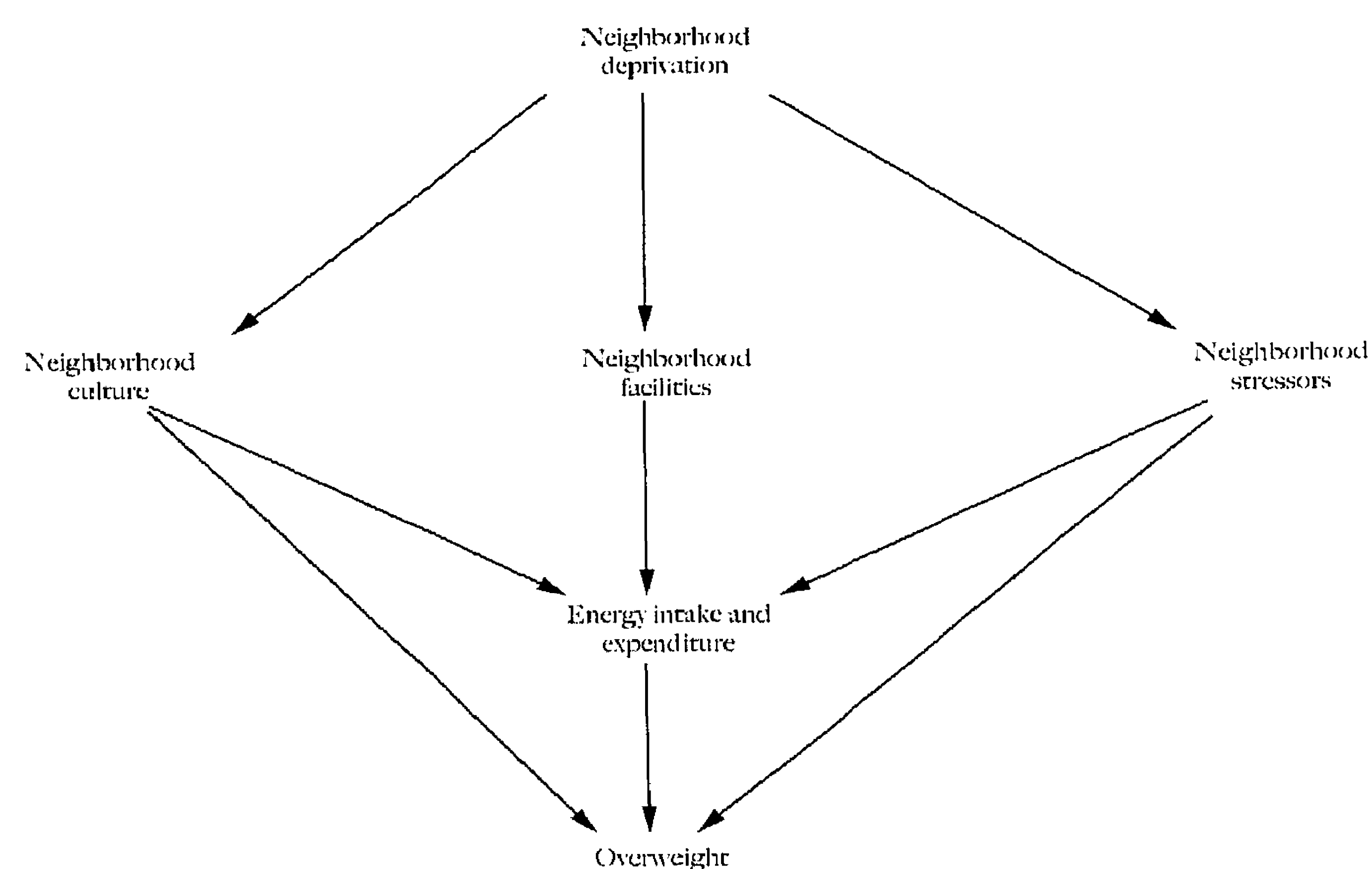


Figure 3. Conceptual model for the explanation of neighborhood inequalities in overweight (adapted from Van Lenthe and Mackenbach, 2002)

SUBJECTS AND METHODS

Study sample

Data for the present study were available from the fourth data collection of the Longitudinal Aging Study Amsterdam (LASA) in 2001/2002. LASA is an ongoing multidisciplinary longitudinal study of predictors and consequences of changes in autonomy and well being in the aging population with an over-sampling of men and older-old people. The design of this longitudinal study has been described in full detail elsewhere (Deeg, Knipscheer, & Van Tilburg, 1993). Briefly, a nationally representative random sample of older adults stratified by age and sex was drawn from population registers of 11 municipalities in three culturally distinct geographical areas in the Netherlands. Subjects who completed the fourth data collection cycle in 2001/2 were included in the present study ($N = 1691$). As the association between BMI and adiposity changes with aging (Gallagher et al., 1996; Seidell and Visscher, 2000) and to maintain comparability with recent studies in the Netherlands (Gast, Frenken, Van Leest, Wendel-Vos, & Bemelmans, in press; Van Lenthe & Mackenbach, 2002), subjects older than 70 years of age were excluded from the analyses. Deletion of cases with no data on postal code, neighborhood socio-economic status ($n = 2$) and income ($n = 25$) left a final sample of 470 participants (230 men and 240 women).

Socio-economic neighborhood status and individual socio-economic status

Neighborhood socio-economic status was assessed using data from Statistics Netherlands on (1) average income per household, (2) percentage of households with low income, (3) percentage of unemployed people, and (4) percentage of households with low educational level. Factor loadings for these variables were all $> .70$. From these factors, a single score was computed in which a higher score corresponded with a higher socio-economic status of the neighborhood. These data were linked to participants using their four-digit postal code. A median split was used to categorize respondents in either low ($n = 235$) or high ($n = 235$) socio-economic status neighborhoods.

Educational level and personal income were used as individual indicators of socio-economic status using closed questions. Respondents were asked to report on their highest attained education, ranging from (1) elementary school not completed to (9) university education. Monthly income in guilders was asked using categories ranging from (1) $f 1.000 - f 1.250$ ($€ 453,78 - € 567,23$) to (12) $> f 5.000$ ($€ 2.268,90$). For educational level, responses were recoded into (1) no education ($n = 34$), (2) elementary and lower education ($n = 207$), (3) secondary and intermediate education ($n = 147$), and (4) higher education ($n = 82$). With regard to monthly income level, quartiles were used to categorize respondents. One hundred and eighty respondents were in the first quartile ($f 1.000 - f 2.500$ ($€ 453,78 - € 1.134,45$)), 138 respondents were in the second quartile ($f 2.501 - f 3.500$ ($€ 1.134,90 - € 1.588,23$)), 97 respondents in the third quartile ($f 3.501 - f 4.500$ ($€ 1.588,68 - € 2.042,01$)), and 117 respondents in the last quartile ($> f 4.501$ ($€ 2.042,46$)).

Crime rates

Data on crime rates were available from 'misdaad-meter' (<http://misdaadmeter.i-serve.net/>), in which the frequency of six crimes (raid, theft/burglary/housebreaking, theft from car, murder and threat/robbery) was assessed at the municipal level using police reports. For each municipality, the frequency of these crime rates was divided by population of that municipality and this resulting score was divided by 1000. These scores were then standardized and summed and ranged from 0 to 100, with a higher score indicating a higher crime rate.

Household density

Within a one-kilometer radius circle of the respondent's postal code, the mean number of addresses was used as an index for the concentration of human activities. Data were

Chapter 2

taken from the 2001/2002 follow-up of the "Quarter and Neighborhood Register 1993", composed by Statistics Netherlands. For each neighborhood, the postal code served as the matching variable with the participants. If there were more postal codes in a neighborhood, the postal code with the largest number of addresses was taken. In the case of more neighborhoods with the same postal code, the neighborhood with the greatest coverage and the largest population was chosen.

Obesity

Body height was measured to the nearest 0.001 m using a stadiometer, while body weight was measured to the nearest 0.1 kg using a calibrated scale. When respondents wore a corset or clothes during the measurement, 1 or 2 kg, respectively, were subtracted from the measured body weight. BMI was computed as body weight (kg) / body height (m)², with BMI ≥ 30 kg/m² indicating obesity.

Walking and cycling

In a face-to-face structured interview based on a validated questionnaire (Stel et al., 2004), respondents were asked to report the frequency and duration of walking outside, bicycling, light and heavy household activities and two sports-related activities during the two weeks preceding the interview. Because of the hypothesized neighborhood influences, only walking and cycling were analyzed in the present study. Multiplying frequency and duration and dividing that score by 14 computed an average time in minutes per day for walking and bicycling.

Statistical analyses

First, logistic regression analysis was used to examine the relationship between neighborhood socio-economic status and obesity, while multivariate analyses with Tukey-HSD contrasts were conducted to assess differences in crime rates and household density between low and high socio-economic status neighborhoods. Since neighborhood deprivation has been reported to be more strongly related with overweight in females than in males (Van Lenthe & Mackenbach, 2002), gender-stratified analyses were conducted. The conceptual framework was tested with linear regression analyses using recommendations for mediation (Baron & Kenny, 1986). In step 1, direct associations between crime rates and BMI and household density and BMI were tested. In the second step, the associations between crime rates and walking were tested. The last step involved testing the associations between walking and cycling with BMI. If the recommendations for

mediation effects were met (i.e. all associations for step 1 through 3 are significant), a full regression model was run. A Sobel test was conducted to test significance of the mediating effect (MacKinnon & Dwyer, 1993). Data were checked for normality distributions and, in case of non-normal distributions, log-transformed. All analyses were adjusted for age, personal income and educational level.

RESULTS

Mean age was 66.49 years (SD = 2.26; range 63-70 years) and mean BMI was 27.48 (SD = 4.14). Men cycled more (15.42 vs. 10.97 minutes per day) and had lower BMI (26.83 vs. 28.10) than women. In low socio-economic status neighborhoods, more crimes (29.81 vs. 14.67) and higher household density (3.42 vs. 2.55) were reported. Table 1 further shows that, in the total sample, 108 persons were obese (23.0%). Women were significantly more likely to be obese (OR = 2.58, 95% CI = 1.60 - 4.16) than men. Neighborhood socio-economic status was not significantly associated with obesity (OR = .78, 95% CI = .50 - 1.23). Gender-stratified analyses revealed that men living in a high socio-economic status neighborhood were less likely (OR = .41, 95% CI = .18 - .93) to be obese than men living in a low socio-economic status neighborhood. Men residing in these high socio-economic status neighborhoods cycled significantly more (19.18 vs. 11.42 minutes per day) than men residing in low socio-economic status neighborhoods. A non-significant association between neighborhood socio-economic status and obesity was found among women (OR = 1.10, 95% CI = .63 - 1.93).

Table 2 shows the results of the linear regression analyses. The initial analyses (Step 1) focused on exploring the associations between neighborhood factors crime and household density with BMI. Because crime and household density were highly correlated ($>.70$), associations with BMI was tested separately for each factor in order to minimize problems with multi-collinearity (Tabachnick & Fidell, 2000). Among men residing in low socio-economic status neighborhoods, higher crime rates ($\beta = .321, p < .001$) and higher household density ($\beta = .276, p = .004$) were associated with higher BMI. The second step involved testing the associations between crime rates and household density with cycling and walking. Higher crime rates were significantly associated with less cycling in both men ($\beta = -.220, p = .023$) and women ($\beta = -.202, p = .033$) residing in low socio-economic status neighborhoods. Higher household density was significantly associated with more walking among women residing in low socio-economic status neighborhoods. In the third step, associations between walking and cycling with BMI showed that more cycling was associated with lower BMI among men ($\beta = -.276, p = .004$) and women ($\beta = -.186,$

$p = .047$) living in low socio-economic status neighborhoods. Additionally, more walking was associated with lower BMI among women residing in low ($\beta = -.258, p = .006$) and high ($\beta = -.357, p < .001$) socio-economic status neighborhoods. Table 2 shows that the requirement for mediation was only met for the associations between crime, cycling and BMI among men living in low socio-economic status neighborhoods. Figure 4 shows the standardized regression coefficients for the full regression model amongst these men. The association between crime rates and BMI was only partially mediated by bicycling (Sobel test = 1.634, $p = .102$). Crime ($\beta = .274, p = .004$) and cycling ($\beta = -.214, p = .044$) were significant correlates of BMI. Sixteen percent of the total effect of crime on BMI was mediated by cycling. The final model explained 13% variance in BMI.

DISCUSSION

The purpose of the present study was to explore potential differences in crime rates and household density between low and high socio-economic status neighborhoods and test whether these differences were related to differences in walking, cycling and BMI in an aging population, based on a recently suggested framework (Van Lenthe and Mackenbach, 2002). Our results showed that low socio-economic status neighborhoods had significantly higher crime rates and household density than high socio-economic status neighborhoods. Furthermore, men living in these high socio-economic status neighborhoods had an almost threefold decreased chance for being obese than men living in low socio-economic status neighborhoods. No significant associations between socio-economic neighborhood status and obesity were found in women.

Replicating findings from the United States (Parks, Housemann, and Brownson, 2003; Yen and Kaplan, 1998), our results showed that residents from low socio-economic neighborhoods were less physically active than residents from high socio-economic neighborhoods. However, this effect was only found for cycling among men. Higher bicycle use among men than among women has been reported elsewhere (Krizek, Johnson, & Tilahun, 2004). One possible explanation for the gender difference in our study may be that lifestyle changes in the elderly have a stronger effect on men than on women, for instance because of retirement from formerly active jobs (Krizek et al., 2004; Nooyens et al., 2005). Non-significant differences between low and high neighborhood socio-economic status and gender were found for walking. Results showed that cycling was inversely related with BMI among residents of low socio-economic status neighborhoods. A similar association between cycling and BMI was recently reported in a longitudinal study in the Netherlands (Nooyens et al., 2005). With regard to walking, a lower BMI was associated with more walking among women, which has been previously reported in

Table 1. Odds ratios for obesity, and mean scores and standard deviations (in parentheses hold density and age across gender, SSNS, and obesity

	N	Age (SD)	N = obese (%)	OR*	95% CI	BMI
Total	470	66.49 (2.26)	108 (23.0)			27.48 (4.14)
Gender						
Men	230	66.42 (2.35)	32 (13.9)	1		26.83 (3.27)
Women	240	66.55 (2.17)	76 (31.7)	2.58	1.60 - 4.16	28.10 (4.76)
<i>p-value</i>		.526		<.001		.001
SSNS						
Low status	235	66.62 (2.16)	60 (26.1)	1		27.58 (4.33)
High status	235	66.37 (2.35)	48 (20.0)	.76	.48 - 1.18	27.38 (3.97)
<i>p-value</i>		.229		.218		.608
Obesity						
Non-obese	362	66.42 (2.23)				25.71 (2.50)
Obese	108	66.73 (2.34)				33.40 (2.85)
<i>p-value</i>		.205				<.001
Men						
Low SSNS	111	66.55 (2.30)	22 (19.8)	1		27.18 (3.65)
High SSNS	119	66.30 (2.40)	10 (8.4)	.38	.17 - .85	26.49 (2.86)
<i>p-value</i>		.427		.018		.106
Women						
Low SSNS	119	66.68 (2.03)	38 (31.9)	1		27.93 (4.87)
High SSNS	121	66.43 (2.31)	38 (31.4)	1.09	.62 - 1.90	28.25 (4.67)
<i>p-value</i>		.372		.775		.607

* Adjusted for age, personal educational level and personal income level

for BMI, cycling, walking, social status neighborhood score (SSNS), crime rates, house-

Cycling	Walking	SSNS	Crime	Houshold density	SS
13.15 (23.68)	25.63 (33.61)	-0.85 (.88)	22.08 (27.03)	2.97 (1.34)	
15.42 (28.48)	27.30 (36.66)	-.11 (.92)	21.87 (26.40)	3.07 (1.30)	
10.97 (17.73)	24.03 (30.39)	-.06 (.85)	22.28 (27.66)	2.89 (1.37)	
.042	.292	-.492	.872	.150	
10.86 (20.51)	26.98 (33.96)	0.71 (.80)	29.81 (30.82)	3.42 (1.41)	
15.34 (26.23)	24.34 (33.29)	.51 (.43)	14.67 (20.26)	2.55 (1.11)	
.041	.394	<.001	<.001	<.001	
14.24 (25.39)	27.43 (34.37)	-.05 (.84)	21.01 (26.20)	2.94 (1.32)	
9.47 (16.32)	19.63 (30.31)	-.20 (1.00)	25.67 (29.49)	3.08 (1.39)	
.066	.034	.134	.116	.335	
11.42 (22.02)	28.19 (33.41)	-.79 (.83)	29.79 (30.68)	3.54 (1.32)	
19.18 (33.10)	26.47 (39.58)	.52 (.41)	14.49 (19.01)	2.62 (1.10)	
.039	.723	<.001	<.001	<.001	
10.35 (19.07)	25.86 (34.57)	-.63 (.77)	29.82 (31.08)	3.31 (1.47)	
11.59 (16.36)	22.24 (25.66)	.51 (.45)	14.85 (21.50)	2.47 (1.13)	
.586	.357	<.001	<.001	<.001	

Table 2. Standard errors (SE), unstandardized (U) and standardized (S) regression coefficients from the mediation analyses with crime rates and household density as independent variables, and walking and cycling as mediating variables, and BMI as dependent variable.
All analyses adjusted for age, personal educational level, and personal income level

	U	SE	S	U	SE	S	U	SE	S	U	SE	S
Step 1												
Crime-BMI	.038	.011	.321***	.015	.014	.101	.011	.015	.075	-.027	.021	-.126
HD-BMI	.759	.256	.276**	.387	.243	.149	.115	.310	.035	-.256	.399	-.061
Step 2A												
Crime-walking	.004	.002	.185	.002	.003	.056	.003	.002	.162	.005	.003	.172
Crime-cycling	.005	.002	-.220*	-.005	.003	-.152	-.004	.002	-.202*	-.004	.003	-.124
Step 2B												
HD-walking	.042	.044	.091	-.039	.050	-.075	.024	.039	.056	.122	.048	.236*
HD-cycling	-.083	.046	-.171	.000	.055	.000	-.016	.038	-.039	-.052	.050	-.095
Step 3												
Walking-BMI	.018	.016	.106	-.016	.019	-.080	-.032	.011	-.258**	-.044	.011	-.357***
Cycling-BMI	.048	.016	-.276**	.019	.021	-.084	.023	.011	-.186*	-.015	.012	-.112

BMI = body mass index; HD = household density

*** = $p < .001$; ** = $p < .01$; * = $p < .05$

similar age groups (Thompson, Rakow, & Perdue, 2004).

The lack of a full mediating effect of cycling in the association between crime and BMI indicates additional behavioral mediators may account for this association. Recent reviews on environmental factors showed no associations between crime rates and diet in other age groups (Brug & Van Lenthe, 2005), and because caloric and fat intake in the elderly population have been found to remain stable (Garry, Hunt, Koehler, Van der Jagt, & Vellas, 1992), this additional behavioral mediator may be related to physical inactivity. Higher crime rates have been found to be related to increased inactivity in adolescents (Gordon-Larsen, McMurray, & Popkin, 2000) and higher crime rates may also be related to increased inactivity, which is common among older people in Western countries (Centers for Disease Control and Prevention, 1998; Stevens, Bult, De Greef, Lemmink, & Rispen, 1999). The available data did not allow us to test the relation between crime rates, inactivity, and BMI.

Regarding the proposed framework (Van Lenthe & Mackenbach, 2002), an interesting pattern emerged from our analyses. Men living in low socio-economic status

neighborhoods had an increased chance of being obese when compared with men living in high socio-economic status neighborhoods. Furthermore, these men cycled on average about one hour per week less than men living in high socio-economic status neighborhoods. Assuming energy intake remains the same, this difference in cycling (approximating one hour per week) could account for up to 3.15 kg of weight gain per year. Less cycling was significantly associated with higher crime rates in these men and, importantly, significantly higher crime rates were observed in low socio-economic status neighborhoods. Following the mechanisms outlined in the framework by Van Lenthe and Mackenbach (2002), low socio-economic status neighborhoods have higher crime rates, which, in turn, are associated with less cycling and higher BMI in older men. In contrast, no significant association was found for risk of obesity between low and high status neighborhoods amongst women. Although less walking was associated with a higher BMI in women, no significant differences in time spent in walking emerged between women living in low or high socio-economic status neighborhoods. Consequently, pathways linking neighborhood deprivation and environmental factors with walking and cycling may differ between men and women.

The results of our study should be viewed in light of several limitations. First, height and weight was used to determine BMI and obesity. Due to a decline in stature, use of height commonly overestimates BMI in the elderly and obesity in this age group is probably better reflected by waist circumference than by BMI (Gallagher et al., 1996; Seidell & Visscher, 2000; Visscher et al., 2001). Second, physical activity was assessed subjectively. Although interviews are regarded as more valid than questionnaires (Dishman, Washburn, and Schoeller, 2001), self-reported behavior is known to be sensitive to over- and underreporting (Schwarz, 1999). Third, we investigated only a limited amount of environmental factors. Several studies have indicated that factors such as greenery and recreational spaces (Wendel-Vos et al., 2004), aesthetics and proximity to facilities (Van Lenthe, Brug, & Mackenbach, 2005) influence physical activity in the Netherlands, as well as elsewhere in the world (De Bourdeaudhuij, Sallis, & Saelens, 2003; Humpel et al., 2004; Owen, Humpel, Leslie, Bauman, & Sallis, 2004). Finally, we used cross-sectional analyses so no causal patterns between the variables studied could be identified. For instance, individuals who are more physically active may also seek out neighborhoods that allow them to be physically active. A major strength of our study was the use of objective measures for height and weight. Reported body weight and height would probably have led to attenuated relations since body weight is especially underreported in obese persons.

Our results suggest that interventions aiming to prevent weight gain and obesity

in the elderly population may need to target increased physical activity rates, especially bicycle use among residents of low socio-economic status neighborhoods and walking among women. Traditionally, interventions to increase PA levels have used educational and/or cognitive-behavioral strategies, for instance providing the target audience with information on health benefits of regular physical activity. These interventions have been based mainly on social-cognitive models, such as the Theory of Planned Behavior and Social-Cognitive Theory (Ajzen, 1991; Bandura, 1998; Baranowski et al., 2003; Brassington, Aienza, Perezck, DiLorenzo, & King, 2002; Courneya, 1995; King, 2001). Future studies may need to explore whether behavior-specific social cognitions, such as attitude, self-efficacy and intentions mediate the effect of environmental factors on walking and cycling, especially since these factors have been found to mediate environmental influences on physical activity in other age groups (De Bruijn et al., 2006). Thus, whilst the Van Lenthe and Mackenbach framework (2002) provides a good starting point for explaining neighborhood inequalities and facilities in overweight and obesity related behaviors, we content that, in line with recent calls (Baranowski et al., 2003; De Bruijn et al., 2006; Kremers et al., 2006; Owen et al., 2004; Pikora, Giles-Corti, Bull, Jamrozik, & Donovan, 2003; Satariano & McAuley, 2003; Spence & Lee, 2003) this framework may need to be expanded with behavior-specific cognitions that act as mediators in the physical environment – physical activity relationship. The importance of such a framework is to provide a scientific and empirical base for the development of weight gain prevention interventions that can be more effectively targeted at individuals, their environments, or both (Booth et al., 2001; Cohen, Scribner, & Farley, 2000; McKinlay, 1995).

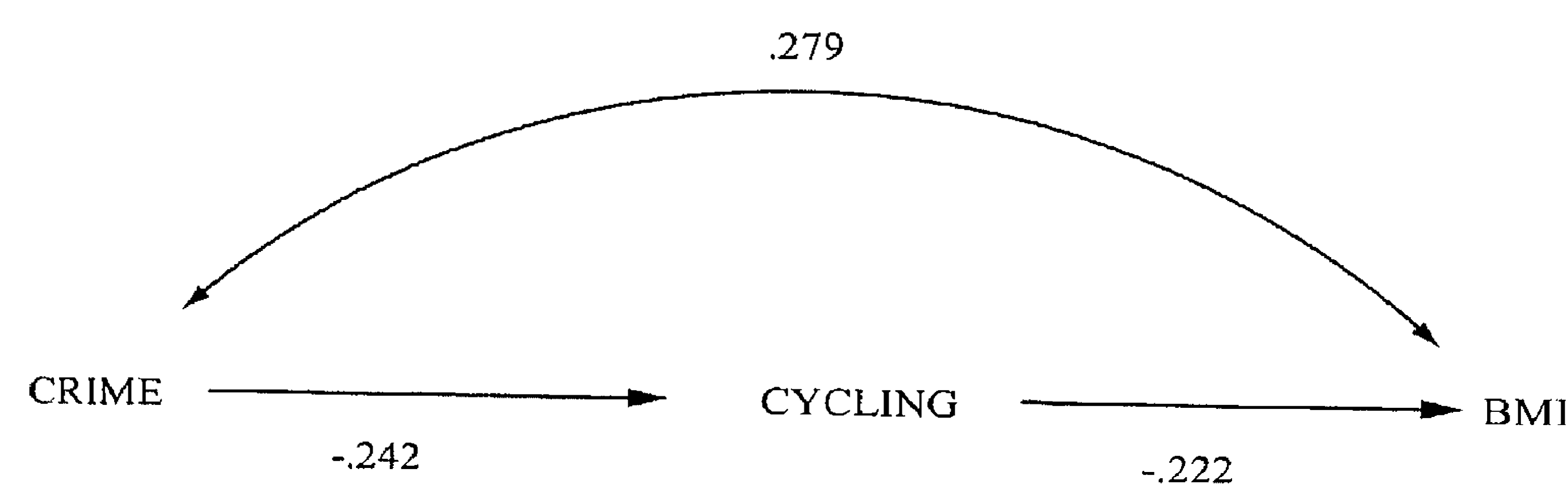


Figure 4. Significant regression coefficients from final model for the associations between crime rates, cycling and BMI among men residing in low socio-economic status neighborhoods

Chapter 3

Determinants of adolescent bicycle use for transportation and snacking behavior

Based on: G.J. de Bruijn, S.P.J. Kremers, H. Schaalma, W. van Meehelen, and J. Brug (2005). Determinants of adolescent bicycle use for transportation and snacking behavior. *Preventive Medicine*, 40: 658-667

ABSTRACT

Background: The prevalence of obesity has reached epidemic proportions in many countries and is largely due to behavioral factors that disrupt the energy balance. The purpose of the study was to test how well our conceptual model, combining factors from the Theory of Planned Behavior and the Theory of Triadic Influence, explained two behaviors related to the energy balance, namely bicycle use for transportation and snacking behavior in a Dutch adolescent sample.

Methods: Data were gathered in an 1997 cross-sectional sample of adolescents ($n = 3,859$; mean age 14.8 years, $SD = 1.6$) on snacking behavior, bicycle use, demographics, and potentially important environmental, cognitive and psychological determinants. Data were analyzed using bivariate correlations, multiple linear and binary logistic regression analyses.

Results: Less snacking behavior was associated with female gender and more positive intention, a more positive attitude, and stronger perceived behavioral control towards restricting snacking. Students who used their bicycle for transportation were more likely to attend secondary education, to be native Dutch, to go to school in a less-urbanized city, to be younger, had a more positive intention and perceived stronger behavioral control and subjective norm towards bicycle use.

Conclusions: The inclusion of environmental factors increased our understanding of bicycle use for transportation and snacking behavior in adolescents. The environmental factors are suggested to be taken into account in interventions aimed at changing these behaviors in more healthy directions.

INTRODUCTION

The prevalence of obesity is increasing rapidly in developed and developing countries (Martorell, Kettel Kahn, Hughes, and Grummer-Strawn, 2000; Visscher, Kromhout, and Seidell, 2002; World Health Organization, 1997) and presents a major health risk because of its association with a wide range of conditions such as type 2 diabetes, heart disease, hypertension, osteoarthritis, some cancers, disability for work and premature death (Visscher and Seidell, 2001; Garrison, Higgins, and Kannel, 1996). Obesity also impacts on the number of life-years (Peeters et al., 2003). There is evidence for increasing trends of overweight and obesity in children and adolescents in the United States and Europe, including the Netherlands (Fredrik, Van Buuren, Wit, Verloove-Vanhorick, 2000; Guillaume, Lapidus, Beckers, Lambert, Bjorntorp, 1995; Kautiainen, Rimpela, Vikat, and Virtanen, 2002; Mokdad, Bowman, Ford, Vinicor, Marks, and Koplan, 2001; Moreno, Sarria, Fleta, Rodriguez, and Bueno, 2000; Prentice and Jebb, 1995; Rasmussen, Johansson, Hansen, 1999; Sorensen, Sabroe, Gillman, 1997). Childhood and adolescent obesity is an important determinant of adult obesity (Abraham, Collins, and Nordsieck, 1971; Guo, Wu, Chumlea, and Roche, 2002; Must and Strauss, 1999) and is associated with age-specific psychosocial problems such as teasing, poor self-image, emotional problems, stereotyping and distress (Caskey and Felker, 1971; Falkner, Neumark-Sztainer, Story, Jeffery, Beuhring, and Resnick, 2001; Gortmaker, Must, Perrin, Sobol, and Dietz, 1993; Mellin, Neumark-Sztainer, Story, Ireland, and Resnick, 2002; Neumark-Sztainer, Falkner, Story, Perry, Hannan, and Mulert, 2002). Since the rise in obesity prevalence rates has occurred within a limited number of decades, genetic factors are not likely to be the main cause of the epidemic (Hill, 1998). Obesity is the result of a positive energy balance in which the energy intake (from the diet) exceeds energy expenditure (from physical activity) over a longer period of time. Since most obesity treatment programs fail to achieve long-term results, a stronger focus on prevention seems necessary (Bar-Or, Foreyt, Boucharde, et al., 1998; Goran, Reynolds, and Lindquist, 1999).

Various energy balance-related behaviors have been identified, such as regular physical activity (Goran, Reynolds, and Lindquist, 1999) and the consumption of fiber (World Health Organization, 2003) but also the consumption of energy dense foods (World Health Organization, 2003), large portion sizes (Nielsen and Popkin, 2003; Rolls, Morris, and Roe, 2002; Young and Nestle, 2002) and engaging in an inactive life style (Coackley, Rimm, Colditz, Kawachi, and Willet, 1998; Tucker and Friedman, 1989; Van Rossum et al., 2002). In order to develop effective weight gain prevention interventions, it is necessary to have insight into the determinants of behaviors related

to the energy balance. Health behaviors, including energy balance-related behaviors, are usually studied using social-cognitive theories. One of the most frequently used is the Theory of Planned Behavior (Ajzen, 1988; 1991). This theory postulates that a particular behavior can be predicted from the intention to perform this behavior. The intention, in turn, can be predicted from three main psychosocial or proximal factors related to that behavior, namely attitude, subjective norm and perceived behavioral control. A person's attitude towards a specific behavior is a result of their beliefs about the consequences of that behavior and the person's evaluation of those beliefs. The subjective norm consists of a person's belief about what important others think about this person performing this behavior. Perceived behavioral control is a result of beliefs concerning access to the necessary resources and opportunities to perform the behavior successfully, weighted by the power of each factor. Apart from its influence on behavioral intention, perceived behavioral control is also assumed to influence behavior directly (Ajzen, 1988). Ajzen (2002) and Ajzen and Fishbein (1980) point out that attitude, subjective norm and perceived behavioral control can be accurately assessed through direct questions, if the underlying beliefs are not the focus of the study. Attitude can be directly assessed through questions that ask respondents to evaluate the behavior under study on, for instance, a good-bad scale and a pleasant-unpleasant scale, while subjective norm can be directly assessed by asking a person if important others around him or her believe he or she should engage in the behavior under study. Perceived behavioral control can be directly assessed by asking a person about his or her perception of the extent to which the behavior under study is easy or difficult and the individual's perception of his or her abilities to succeed in performing the behavior. Various studies have shown that the above-mentioned social-cognitive factors have considerable value in explaining and predicting health-related behaviors (Godin and Kok, 1996), including energy balance-related behaviors (De Bourdeaudhuij and Sallis, 2002; Mesters and Oostveen 1994).

Several potential additional "external" determinants of energy balance-related behaviors have recently been proposed, such as environmental influences (Humpel, Owen, and Leslie, 2002; Kotz and Story, 1994; Zask, Van Beurden, Barnett, Brooks, and Dietrich, 2001), parenting styles (Schmitz, Lytle, Phillips, Murray, Birnbaum, and Kubik, 2002), ethnicity (Myers, Strikmiller, Webber, and Berenson, 1996; Wilcox, Castro, King, Houseman, and Browson, 2000), gender and psychological factors (Schmitz, Lytle, Phillips, Murray, Birnbaum, and Kubik, 2002). According to the Theory of Planned Behavior (Ajzen, 1991), these external or so-called distal variables are thought to have an effect on behavior through the three proximal variables and intention. However, the

Theory of Planned Behavior does not focus on these distal variables. A theory that does is the Theory of Triadic Influence (Flay and Petraitis, 1994), which states that distal determinants of health behaviors can be divided into three types of influence, namely the cultural environment, the social environment, and biological and personality factors. Cultural factors represent the broad macro- environment, including factors such as religion and ethnicity. The social situation represents the immediate micro-environment, including influences such as family structure, parenting styles and factors relating to the physical environment. Biological and personality factors represent stable intrapersonal influences, originating in inherited dispositions (gender, age) and personality characteristics. Our conceptual research model (see Figure 5) combined the Theory of Planned Behavior with the more distal factors of the Theory of Triadic Influence.

The purpose of the current study was two-fold. First, we tested how well our conceptual model explained snacking behavior and bicycle use in a Dutch adolescent population. Second, we wanted to identify the possible proximal and distal determinants of these two energy balance-related behaviors in this population. In line with the Theory of Planned Behavior, we expected snacking behavior and bicycle use to be best predicted by intention, while intentions were hypothesized to be best predicted by the proximal factors in the conceptual model. With regard to intention for both behaviors, we expected the influence of the distal factors to be mediated by the proximal factors, while their influence on behavior would be mediated by the proximal factors and intention.

METHODS

Subject and procedures

In 1997, 273 high schools in the Netherlands were randomly selected to participate in the present study. Sixty-eight schools for secondary education (27%) and 7 schools for vocational education (40%) agreed to participate after receiving written information about the study. The students in these schools were asked to complete a self-administered questionnaire during school hours. A total of 3859 students (55.2% girls) completed the questionnaire. Mean age was 14.8 years ($SD=1.6$). Most students were living with both parents (83.1%) and were native Dutch (84.3%). The immigrant students were mostly of Turkish or Moroccan origin. Two thirds of the students (67.8%) attended secondary education, while most schools (60.4%) were located in towns with fewer than 50,000 inhabitants.

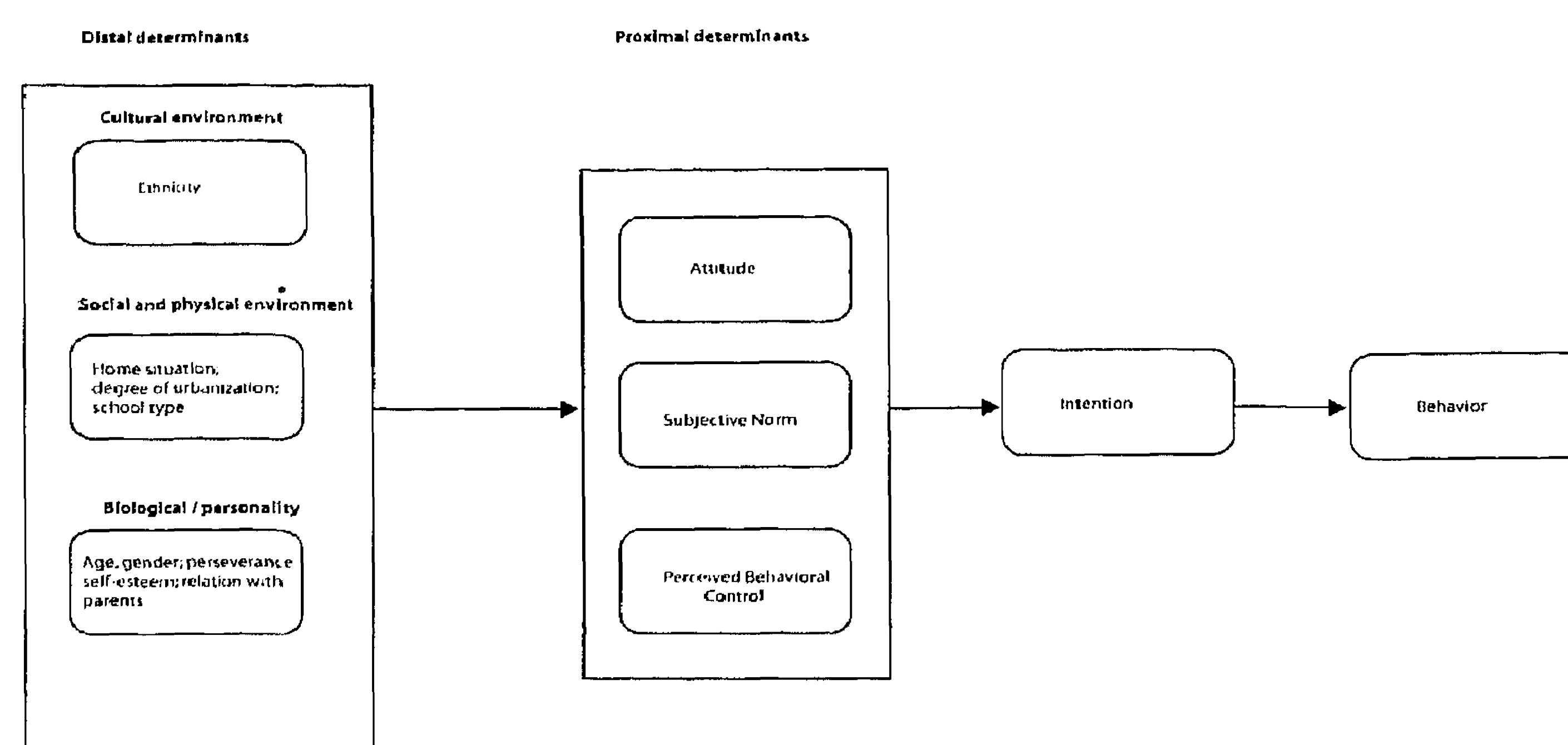


Figure 5. Conceptual research model

Measures

Consumption of snacks was assessed using relevant questions from a validated food frequency questionnaire designed to assess fat intake (Van Assema, Brug, Kok, and Brants, 1992). Four items questioned students on the number of times a week they consumed the following snacks: fried snacks, nuts and potato chips, pastries and chocolate candy bars, and cookies. A single score was computed for the number of snacking occasions per week. Bicycle use was assessed by presenting students with three frequently occurring situations in which transportation is required, namely going to school, going to a sports club and going to a hobby club. Students could choose between walking, cycling, using a moped, going by bus or being taken to school by car. In addition, students indicated whether or not they were a members of a sports club or a hobby club. Taking membership into account, students were divided into one of the following categories: those who never used their bicycles for transportation ($n=802$) and those who occasionally or always used their bicycles for transportation ($n=3057$).

We assessed attitude and perceived behavioral control with two items and an average score was obtained by summing and dividing the scores. Intention and subjective norm were assessed with one item each on five-point Likert scales (see Appendix). We further assessed three types of distal variables: ethnicity, social environment and biological

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/personality variables. Ethnicity (0 = immigrant; 1 = native) was based upon the definition used by Statistics Netherlands (2000). A student was considered to be native Dutch if both parents had been born in the Netherlands and an immigrant inhabitant if one or both parent(s) had not been born in the Netherlands. Social environment variables were the home situation (0 = not living with both parents; 1 = living with both parents), degree of urbanization of the town where their school was located (<50,000 inhabitants = 0; $\geq 50,000$ inhabitants = 1) and school type (0 = vocational education; 1 = secondary education). Biological variables were age and gender (0 = boy; 1 = girl). Psychological variables were perseverance, self-esteem and relation with parents. Based on empirical and theoretical evidence, we constructed two scales with four items each to assess perseverance and self-esteem. Relation with parents was assessed using questions from Student Research 1992 (De Zwart and Warmaar, 1992). The items for the psychological variables were scored on five-point Likert scales in such a way that a positive score meant a greater self-esteem, more perseverance and a better relation with parents respectively. An average score for each of the psychological variables was obtained by summing and dividing the scores.

Analyses

To identify potential correlates of the two behaviors under investigation, we computed correlations between behavior, distal variables and their respective intention and proximal variables. We calculated Pearson's r for the linear variables and Spearman's Rho for dichotomous variables. We used the magnitude of the effect size (r^2) as a source of information for the correlational analyses, since it is insensitive to group sizes (Tabachnick and Fidell, 1996). Effect size interpretations were based on Cohen's (1988, p. 285) descriptive guidelines. A large effect size was defined as larger than or equal to .14 ($r^2 \geq .14$), which means that 14 or more percent of variance is accounted for. Effect sizes between .06 and .14 were regarded as medium effects sizes, while a small effect size was defined as larger than or equal to .01.

Our conceptual model was tested in two sets of stepwise regression analyses. In the first set, intention was regressed in two steps on the potential distal and proximal variables: distal variables were entered in Step 1 and proximal variables were entered in Step 2. In the second set of analyses, the behavior under study was regressed in three steps entering the same set of variables in Step 1 and 2 and entering intention in Step 3. Linear regression analyses were used for intentions and snacking behavior, while binary logistic regression analysis was used for bicycle use.

RESULTS

Univariate analyses: Correlations and effect sizes

Table 4 shows the correlations of both intentions and behaviors with their respective proximal and distal variables. Students who had a positive intention towards restricting their snacking frequency had a more positive attitude, perceived more subjective norm, perceived greater behavioral control, had lower self-esteem and were more likely to be female. Regarding snacking behavior, students who snacked on few occasions had a more positive intention and attitude towards restricting their snacking frequency, perceived greater behavioral control, were more likely to be girls. Furthermore, they were more likely to attend a vocational school and to live with both parents, and to have a better relation with their parents. Those with a positive intention to use a bicycle for transportation as often as possible had a more positive attitude, perceived more behavioral control and subjective norm and were likely to be younger and to attend secondary education. With regard to bicycle use, students who used their bicycles often or always had a more positive intention and attitude, perceived more behavioral control, and were younger than students who never used their bicycles. In addition, bicycle users were more likely to attend secondary education, to be a native Dutch, to live with both parents, and to go to school in a less-urbanized town than never-users.

Multivariate analyses: intention to restrict snacking frequency and snacking behavior

The mean number of snacking occasions per week was 10.5 ($SD=5.0$). Eating cookies accounted for the largest number of snacking occasions per week (4 ± 2.5) and eating fried snacks for the fewest (1.4 ± 1.3).

In the two-step multiple linear regression analysis on intention to restrict snacking frequency, the distal factors explained 10% of the total variance in intention (Table 5A). In the second step of the analysis, attitude was the strongest proximal correlate of intention, while perceived behavioral control and subjective norm were also significantly associated. With regard to the distal variables, gender remained a strong correlate. Furthermore, self-esteem and relation with parents were significant distal correlates. Girls, students with low self-esteem and students with a good relationship with their parents were more likely to intend to restrict their weekly snacking frequency. The inclusion of the proximal variables in the final step increased the total amount of explained variance to 34%. Table 5B shows the three-step linear regression analysis on snacking frequency. In the first step of the analysis, only ethnicity was not significantly associated with snacking behavior. The distal variables explained 6% of the total variance in behavior,

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Table 4. Bivariate correlations between behavior, intention, proximal factors, and distal factors (n = 3859)

	IS	SB	IB	BU
Intention (+2 = most positive; -2 = most negative)		.42 ^b		.27 ^a
<i>Proximal factors</i>				
Attitude (+2 = most positive; -2 = most negative)	.51 ^b	.40 ^b	.63 ^c	.21 ^a
Subjective norm (+2 = highest; -2 = lowest)	.19 ^a	.05	.33 ^b	.19 ^a
PBC (+2 = highest; -2 = lowest)	.31 ^b	.30 ^b	.54 ^c	.25 ^a
<i>Distal factors</i>				
Ethnicity (0 = immigrant; 1 = Dutch)	-.01	-.04	.07	.17 ^a
Home situation (0 = not with both parents; 1 = with both parents)	.05	-.08	.05	.09
Degree of urbanization (0 < 50,000 inhabitants; 1 > 50,000 inhabitants)	-.02	-.03	-.02	-.13 ^a
School type (0 = vocational; 1 = recreational)	-.04	-.11 ^a	.13 ^a	.28 ^a
Age	.05	.06	-.14 ^a	-.22 ^a
Gender (0 = boy; 1 = girl)	.29 ^a	.19 ^a	.06	-.01
Perseverance (+2 = highest; -2 = lowest)	.04	.04	.06	-.06
Self-esteem (+2 = highest; -2 = lowest)	-.11 ^a	-.07	.00	.00
Relation with parents (+2 = most positive; -2 = most negative)	.07	.08	.10 ^a	.03

IS = intention to restrict snacking occasions; IB = intention to use a bicycle for transportation; SB = number of snacking occasions per week; BU = bicycle use (0 = never user; 1 = occasionally/always); PBC = perceived behavioral control

^a = small effect size; ^b = medium effect size; ^c = large effect size

while the inclusion of proximal variables in step 2 increased the explained variance to 21%. In the third step of this analysis, intention was found to be the strongest correlate. In addition, attitude and perceived behavioral control were significantly associated proximal variables. Students who snacked on fewer occasions had greater intention to restrict their snacking frequency, had a more positive attitude towards restricting it and perceived greater behavioral control. Subjective norm had no significant association with snacking behavior in the final step. With regard to the distal variables in the final step, home situation, degree of urbanization, school type, and self-esteem remained in the regression equation, although the beta values for the distal variables in the third step were low. The inclusion of intention in the final step increased the total amount of explained variance to 25%.

Table 5A. Stepwise linear regression analysis with intention to snack less as dependent variable and distal factors (Step 1) and proximal factors (Step 2) as independent variables

	Step 1	R ²	Step 2	R ²
<i>Distal factors</i>				
Ethnicity (0 = immigrant; 1 = Dutch)	-.02	.10	-.00	.34
Home situation (0 = with both parents; 1 = not with both parents)	-.03		-.02	
Degree of urbanization (0 < 50,000 inhabitants; 1 > 50,000 inhabitants)	-.02		-.01	
School type (0 = vocational; 1 = secondary)	.01		.01	
Age	.05**		.02	
Gender (0 = boy; 1 = girl)	.27***		.21***	
Perseverance (+2 = highest; -2 = lowest)	.07***		.02	
Self-esteem (+2 = highest; -2 = lowest)	-.07***		-.07***	
Relation with parents (+2 = most positive; -2 = most negative)	.09***		.03*	
<i>Proximal factors</i>				
Attitude (+2 = most positive; -2 = most negative)			.36***	
Subjective norm (+2 = highest; -2 = lowest)			.13***	
PBC (+2 = highest; -2 = lowest)			.20***	

PBC = Perceived Behavioral Control

*** = $p < .001$; ** = $p < .01$; * = $p < .05$ *Multivariate analyses: bicycle use behavior and intention to use a bicycle*

A total of 802 students (20.8%) indicated that they never used a bicycle for transportation, while 3057 (79.2%) students indicated using a bicycle for transportation occasionally or always.

Table 6A shows the two-step multiple linear regression analysis on the intention to use a bicycle for transportation as often as possible. In the first step of the analysis, the distal factors explained 5% of the total variance in intention. Gender, age, ethnicity, school type, perseverance and relation with parents were significantly associated with bicycle use intention. In the final step of this analysis, the proximal variables appeared to mediate the influence of the distal factor on intention, with attitude as the strongest correlate of intention. Gender remained a significant correlate, although its beta value was low: girls were more likely than boys to have a positive intention to use a bicycle for transportation as often as possible. The inclusion of the proximal variables increased the amount of

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Table 5B. Stepwise linear regression analysis with snacking occasions as dependent variable and distal factors (Step 1), proximal factors (Step 2), and intention (Step 3) as indepent variables

	Step 1	R ²	Step 2	R ²	Step 3	R ²
<i>Distal factors</i>						
Ethnicity (0 = immigrant; 1 = Dutch)	-.03	.06	-.02	.21	-.02	.25
Home situation (0 = with both parents; 1 = not with both parents)	-.05***		-.04**		-.04*	
Degree of urbanization (0 < 50.000 inhabitants; 1 > 50.000 inhabitants)	-.05**		-.04*		-.04**	
School type (0 = vocational; 1 = secondary)	-.06**		-.06***		-.06***	
Age	.04*		.01		.00	
Gender (0 = boy; 1 = girl)	.17***		.12***		.07***	
Perseverance (+ 2 = highest; -2 = lowest)	.05**		.01		.01	
Self-esteem (+ 2 = highest; -2 = lowest)	-.06**		-.07***		-.05**	
Relation with parents (+ 2 = most positive; -2 = most negative)	.09***		.04*		.03*	
<i>Proximal factors</i>						
Attitude (+ 2 = most positive; -2 = most negative)			.23***		.19***	
Subjective norm (+ 2 = highest; -2 = lowest)			.01		-.03	
PBC (+ 2 = highest; -2 = lowest)			.20***		.15***	
Intention (+ 2 = most positive; -2 most negative)					.25***	

PBC = Perceived Behavioral Control

*** = p < .001; ** = p < .01; * = p < .05

explained variance to 49%.

Table 6B shows the three-step logistic regression analysis on bicycle use. In the first step of the analysis, the 95 percent confidence intervals show that age, gender, ethnicity, home situation, degree of urbanization and school type were significantly associated with bicycle use. The distal variables explained 19% of the variance in bicycle use. In the second step, all three proximal factors were significantly associated with bicycle use, increasing the explained variance to 28%. In the final step of the analyses, the distal variables school type, ethnicity and degree of urbanization remained in the regression equation. Notably they proved to have higher Odds Ratios than the proximal variables and intention. Students who attended secondary education or were native Dutch were nearly three times as likely to use a bicycle for transportation, while students attending a school in a less urbanized city were nearly twice as likely to use a bicycle for transportation. In addition, age, home situation and perseverance remained significantly

Chapter 3

Table 6A. Stepwise linear regression analyses with intention to use a bicycle for transportation as dependent variable and distal factors (Step 1), proximal factors as independent variables

	Step 1	R ²	Step 2	R ²
<i>Distal factors</i>				
Ethnicity (0 = immigrant; 1 = Dutch)	.07***	.05	.02	.49
Home situation (0 = with both parents; 1 = not with both parents)	.03		.01	
Degree of urbanization (0 < 50,000 inhabitants; 1 > 50,000 inhabitants)	.01		.01	
School type (0 = vocational; 1 = secondary)	.12***		.03*	
Age	-.11***		-.02	
Gender (0 = boy; 1 = girl)	.09***		.04	
Perseverance (+2 = highest; -2 = lowest)	.08***		-.04	
Self-esteem (+2 = highest; -2 = lowest)	-.02		-.02	
Relationship with parents (+2 = most positive; -2 = most negative)	.09***		.01	
<i>Proximal factors</i>				
Attitude (+2 = most positive; -2 = most negative)			.39***	
Subjective norm (+2 = highest; -2 = lowest)			.12***	
PBC (+2 = highest; -2 = lowest)			.33***	

PBC = Perceived Behavioral Control

*** = $p < .001$; ** = $p < .01$; * = $p < .05$

associated with bicycle use. Students living with both parents and who perceived themselves as less persevering were more likely to use a bicycle for transportation. Regarding the proximal variables and intention, those who perceived more subjective norm and behavioral control and those who had a more positive intention were more likely to use a bicycle for transportation as often as possible. The inclusion of intention in the final step increased the amount of explained variance by one percent.

DISCUSSION

In recent years, increased scientific attention has focused on the influence of the environment, the social surroundings and personality factors on the prevalence of obesity (Hill, 1998; Sallis, Conway, Prochaska, McKenzie, Marshall, and Brown, 2001; Sallis, Kraft, and Linton, 2002; Story, Neumark-Sztainer, and French, 2002). If energy balance-related behaviors are to be understood, health behavior related research models should

Table 6B. Stepwise logistic regression analyses with bicycle use as dependent variable and distal factors (Step 1), proximal factors (Step 2) and intention (Step 3) as independent variables

	Step 1			Step 2			Step 3		
	OR	95% CI	R ²	OR	95% CI	R ²	OR	95% CI	R ²
<i>Distal factors</i>									
Ethnicity (0 = immigrant; 1 = Dutch)	3.05	2.49 - 3.75	.19	2.84	2.29 - 3.52	.28	2.84	2.29 - 3.53	.29
Home situation (0 = with both parents; 1 = not with both parents)	1.31	1.07 - 1.61		1.26	1.01 - 1.56		1.25	1.01 - 1.56	
Degree of urbanization (0 < 50,000 inhabitants; 1 > 50,000 inhabitants)	.67	.57 - .80		.65	.55 - .78		.64	.54 - .77	
School type (0 = vocational; 1 = secondary)	3.12	2.59 - 3.75		2.88	2.34 - 3.50		2.87	2.37 - 3.49	
Age	.81	.76 - .86		.84	.80 - .90		.85	.80 - .90	
Gender (0 = boy; 1 = girl)	1.09	.91 - 1.30		.97	.81 - 1.17		.94	.78 - 1.14	
Perseverance (+2 = highest; -2 = lowest)	.98	.94 - 1.01		.94	.91 - .98		.95	.91 - .98	
Self-esteem (+2 = highest; -2 = lowest)	1.01	.97 - 1.04		1.01	.97 - 1.05		1.01	.98 - 1.05	
Relationship with parents	1.04	.99 - 1.08		1.00	.95 - 1.05		1.00	.95 - 1.05	
<i>Proximal factors</i>									
Attitude (+2 = most positive; -2 = most negative)				1.21	1.06 - 1.37		1.00	.86 - 1.15	
Subjective norm (+2 = highest; -2 = lowest)				1.29	1.18 - 1.41		1.24	1.13 - 1.35	
PBC (+2 = highest; -2 = lowest)				1.67	1.50 - 1.86		1.49	1.33 - 1.66	
Intention (+2 = most positive; -2 = most negative)							1.37	1.24 - 1.51	

PBC = Perceived Behavioral Control

*** = $p < .001$; ** = $p < .01$; * = $p < .05$

Table 6B. Stepwise logistic regression analyses with bicycle use as dependent variable and distal factors (Step 1), proximal factors (Step 2) and intention (Step 3) as independent variables

	Step 1			Step 2			Step 3		
	OR	95% CI	R ²	OR	95% CI	R ²	OR	95% CI	R ²
<i>Distal factors</i>									
Ethnicity (0 = immigrant; 1 = Dutch)	3.05	2.49 - 3.75	.19	2.84	2.29 - 3.52	.28	2.84	2.29-3.53	.29
Home situation (0 = with both parents; 1 = not with both parents)	1.31	1.07 - 1.61		1.26	1.01 - 1.56		1.25	1.01-1.56	
Degree of urbanization (0 < 50,000 inhabitants; 1 > 50,000 inhabitants)	.67	.57 - .80		.65	.55 - .78		.64	.54-.77	
School type (0 = vocational; 1 = secondary)	3.12	2.59 - 3.75		2.88	2.34 - 3.50		2.87	2.37-3.49	
Age	.81	.76 - .86		.84	.80 - .90		.85	.80 - .90	
Gender (0 = boy; 1 = girl)	1.09	.91 - 1.30		.97	.81 - 1.17		.94	.78 - 1.14	
Perseverance (+ 2 = highest; -2 = lowest)	.98	.94 - 1.01		.94	.91 - .98		.95	.91 - .98	
Self-esteem (+ 2 = highest; -2 = lowest)	1.01	.97 - 1.04		1.01	.97 - 1.05		1.01	.98-1.05	
Relationship with parents	1.04	.99 - 1.08		1.00	.95 - 1.05		1.00	.95-1.05	
<i>Proximal factors</i>									
Attitude (+ 2 = most positive; -2 = most negative)				1.21	1.06 - 1.37		1.00	.86-1.15	
Subjective norm (+ 2 = highest; -2 = lowest)				1.29	1.18 - 1.41		1.24	1.13-1.35	
PBC (+ 2 = highest; -2 = lowest)				1.67	1.50 - 1.86		1.49	1.33-1.66	
Intention (+ 2 = most positive; -2 = most negative)							1.37	1.24-1.51	

PBC = Perceived Behavioral Control
 *** = p < .001; ** = p < .01; * = p < .05

focus more on the contextual influence of distal variables. In order to study the influence of distal variables on energy balance-related behaviors, we combined the Theory of Planned Behavior with the more distal focus of the Theory of Triadic Influence. We tested this conceptual model in a Dutch adolescent population by examining snacking behavior and bicycle use for transportation. The findings in terms of the proximal factors for both behaviors were in line with our hypotheses and with previous research (Mesters and Oostveen, 1994; Trost, Pate, Dowda, Ward, Felton, and Saunders, 2002; Craig, Golberg, Dietz, 1996). With regard to the distal factors, our results indicated that these factors had a direct association with both behaviors, though the association of the distal factors was stronger for bicycle use than for snacking behavior. Notably, the association of the distal factors with bicycle use was stronger than the associations of the proximal variables or intention. Our results indicated a direct association between bicycle use and the distal variables school type, ethnicity, and degree of urbanization. The inclusion of the distal variables explained a much higher percentage of the variance in bicycle use than in snacking behavior. Furthermore, the inclusion of intention in the analyses added 4% to the explained variance in snacking behavior, but only 1% in the explained variance in bicycle use. This indicates that adolescent snacking behavior may be under greater intentional control than bicycle use.

The direct association between bicycle use and school type, ethnicity, degree of urbanization and age leads us to hypothesize about the possible underlying mechanisms. Secondary school students were nearly three times as likely to use a bicycle than vocational students. However, children from lower socio-economic positions are generally overrepresented at vocational schools. Therefore, the influence of school type on bicycle use could also be attributed to socioeconomic position. Our data set did not allow us to test this hypothesis. Furthermore, the home-school distance is usually greater for vocational students than for secondary students in the Netherlands and although an objective measure of home-school distance was absent in our current data, secondary analyses did indeed show that it took vocational students longer to get to school. Overall, the average time it took never-users to get to school, a sports club or a hobby club was 19, 11, and 14 min, respectively, indicating that using a bicycle would be a realistic option for never-users.

With regard to ethnicity, we found that native Dutch students were nearly three times as likely to use a bicycle as immigrant students. This may reflect a cultural influence, since cycling is very common in the Netherlands; more than 80% of the households have at least one bicycle (Statistics Netherlands, 2002A). It may take time for immigrants to

adapt to the Dutch culture, where bicycle use is embedded in daily life. Since cycling is typical in the Netherlands, generalization of our findings with regard to bicycle use for transportation should be cautioned. Regarding the degree of urbanization, we found that students whose school was situated in a less urbanized town were twice as likely to use a bicycle than students who went to school in a more urbanized town. Since the influence of urbanization was not mediated by the proximal factors or intention, additional influences could play a part. One of these influences might be factors related to the physical environment. Urbanized towns tend to have greater traffic volume and speed, which has been found to decrease the level of comfort cyclists experience (Harkey, Reinfurt, Knuiman, Stewart, and Sorton, 1998).

Some issues in the present study should be noted. The cross-sectional nature implied that no causal relationships could be inferred. According to the Theory of Planned Behavior, a positive attitude precedes intention or behavior. However, a positive attitude can also be the result of the experience of previous behavior. Indeed, in a low-involvement situation, individuals might not tend to put much energy in their decision process: they would be more likely to act without using much rational consideration and form their attitudes after the behavior has occurred (Ray, Sawyer, Rotschild, Heeler, Strong, and Reed, 1973). The concept of dissonance reduction (Festinger, 1957) might be a mechanism that accounts for such an inverse cognition-behavior relationship. We used self-reports to assess snacking frequencies and bicycle use. Since self-reported behavior is prone to both over-reporting and under-reporting (Bandini, Schoeller, Cyr, and Dietz, 1990; Schoeller, 1990), results regarding both behaviors should be interpreted with caution even though, with regard to snacking, a validated questionnaire was used. Proximal and distal variables did not always have good internal consistency. For example, attitude towards restricting snacking frequencies yielded a Cronbach's alpha of 0.56, which is below the generally accepted 0.60 (Nunnally, 1978). Furthermore, the internal consistencies for our psychological factors were only slightly higher than 0.60. Their low standardized regression coefficients in the regression analyses may therefore be partially caused by their low internal consistencies. The available data allowed the inclusion of only a limited set of distal variables. Recent research has indicated a role for such factors as depression (REF!), parental educational level (Xie, Gilliland, Li, and Rockett, 2003), parenting style (Kremers, Brug, De Vries, and Engels, 2003), and accessibility of psychical activity opportunities (Pikora, Giles-Corti, Bull, Jamrozik, and Donovan, 2003). Recent scientific research has also focused on the concept of habit formation (Aarts and Dijksterhuis, 2000). In a study among Dutch adolescents, it was shown that bicycle use

for transportation can become habitual and changing habitual behaviors is an *“inefficient enterprise, since these behaviors are no longer guided by intention”* (Aarts, Paulussen and Schaalma, 1997, p. 371). The potential role of habit has also been acknowledged by Fishbein and Ajzen (1975, p. 371), stating that *“while a person may intend to perform one behavior, by force of habit he may perform an alternative one”*. Thus, relevant additional psychological and environmental factors and habit strength should be included in future research to enhance our understanding of possible determinants of energy balance-related behaviors. Despite the above-mentioned shortcomings of the present study, the results indicate that energy balance-related behaviors, most importantly bicycle use, may not always be planned and reasoned behaviors. Distal factors, such as the cultural and social environment, have a direct association with bicycle use for transportation. Whereas most health-related interventions to date have focused on changing proximal factors of behavior, our results indicate that the inclusion of potential distal factors increased our understanding of bicycle use and snacking behaviors among adolescents. Interventions focusing on behavioral change could be directed at critical target groups, such as immigrant students in urban vocational schools. Our results indicate that such tailored intervention would be more efficient than interventions directed at changing behavior in a general population. Furthermore, the inclusion of distal factors in the study of energy balance-related behaviors will be helpful in the development of interventions to influence those behaviors in a more healthy direction. It confirms the need for interventions to change the so-called obesogenic environment such as the obesogenic elements in the school environment.

Chapter 4

Modeling individual and physical environmental factors with adolescent physical activity

Based on: G.J. de Bruijn, S.P.J. Kremers, G. Lensvelt-Mulders, H. de Vries, W. van Mechelen, and J. Brug (2006). Modeling individual and physical environmental factors with adolescent physical activity. *American Journal of Preventive Medicine*, 30: 507-512

ABSTRACT

Background: Recent calls have been made to consider both environmental factors and individual-level factors in the explanation of physical activity (PA). The present study tested a conceptual model that integrated past PA, relevant environmental-level and individual-level factors and their associations with adolescent PA, using the tenets of the Theory of Planned Behavior (TPB).

Methods: Data were gathered in an adolescent sample ($n = 221$; 60% girls) using questionnaires. PA was assessed in May 2003 and November 2003. TPB-cognitions regarding PA and the environmental factors under study were assessed in November 2003. Confirmatory Factor Analyses and path analyses using AMOS were performed in 2005.

Results: The initial structural model did not provide an acceptable fit to the data. Including a direct path from past PA to current PA significantly improved model fit to an acceptable fit. Including a direct path from past PA to environmental perceptions did not significantly improve model fit. Including a direct path from the environmental variables to current PA did not significantly improve model fit. Current PA was most strongly influenced by past PA, while environmental aesthetics and distance to PA opportunities were indirectly related to adolescents' intention to be physically active. Significant standardized path coefficients ranged from .14 to .34 and explained 17 percent variance in current PA.

Conclusions: Combining past PA, TPB cognitions and environmental factors increased our understanding of their relative influences on adolescent PA. Implications for further research on physical activity are discussed.

INTRODUCTION

Lack of physical activity (PA) among adolescents presents a major burden to public health (U.S. Department of Health and Human Services, 1996; Van Mechelen, Twisk, Post, Snel, and Kemper, 2000) and its increasing prevalence rates and associated health risks underline the need to develop interventions that are aimed at increasing adolescents' PA levels. Theory provides the foundation for PA interventions (Baranowski, Anderson, and Carmack, 1998) and one social-cognitive theory that has proven its worth in understanding PA is the Theory of Planned Behavior (TPB) (Ajzen, 1991). Briefly, the TPB proposes that the most proximal and intrapersonal determinant of volitional behavior is the intention to perform that behavior. In turn, intention is theorized to be predicted by three social-cognitive factors, namely attitude, subjective norm and perceived behavioral control (PBC). Both quantitative and qualitative reviews of the TPB provide support for its use in understanding PA (Godin and Kok, 1996; Hagger, Chatzisarantis, and Biddle, 2002; Hausenblas, Carron, Mack, and Godin, 1997). Nevertheless, a large part of the variance generally remains unexplained (Godin and Kok, 1996), leaving researchers to identify additional intrapersonal factors that may be usefully added to the TPB. Past behavior has frequently been suggested as one such factor. Empirical evidence shows residual effects of past PA on current PA when TPB cognitions are taken into account (Hagger, Chatzisarantis, and Biddle, 2001; Hagger, Chatzisarantis, Biddle, and Orbell, 2001; Norman and Smith, 1995), indicating that past PA is an important intrapersonal determinant of current PA. However, studies investigating the influence of past PA on adolescents' current PA are limited and generally assessed past PA retrospectively with a single item (Hagger, Chatzisarantis, and Biddle, 2001; Hagger, Chatzisarantis, Biddle, and Orbell, 2001), indicating more research is needed using longitudinal designs and more valid assessments of PA.

Although the inclusion of such additional intrapersonal factors may allow for a better understanding of the determinants of PA, recent empirical evidence highlights the importance of physical environmental influences on adolescent PA (De Bruijn, Kremers, Schaalma, Van Mechelen, and Brug, 2005; Dunton, Jamner, and Cooper, 2003; Fein, Plotnikoff, Wild, and Spence, 2004; Molner, Gortmaker, Bull, and Buka, 2004). A focus on these broader determinants of health behavior is consistent with an ecological perspective of behavior (Giles-Corti and Donovan, 2002), but there are significant conceptual and methodological challenges in identifying how such physical environmental factors might influence PA (Bauman, Sallis, Dziewaltowski, and Owen, 2002; Owen, Humpel, Leslie, Bauman, and Sallis, 2004), with many studies on PA

atheoretical (Bauman, Sallis, Dziewaltowski, and Owen, 2002). Since ecological models have generally not included cognitive variables (Baranowski, Cullen, Nicklas, Thompson, and Baranowski, 2003), practical and theoretical progress in understanding PA may benefit from combining the environmental factors used in ecological models with the behavior-specific cognitive factors used in social-cognitive models. Although some authors have argued for the existence of a direct unmediated influence of environmental factors on PA (De Bruijn, Kremers, Schaalma, Van Mechelen, and Brug, 2005; Spence and Lee, 2003), the TPB postulates that the influence of environmental factors is mediated by PBC and intention (Ajzen, 1991). Mediation by social cognitions may provide a plausible explanation why some studies fail to find a strong association between environmental factors and physical activity (Hoehner, Brennan Ramirez, Elliot, Handy, and Brownson, 2005; Huston, Evenson, Bors, and Gizlice, 2003), but determinant studies on PA that have included both environmental-level and individual-level variables (Booth, Owen, Bauman, Clavisi, and Leslie, 2000; Leslie, Owen, Salmon, Bauman, and Sallis, 1999) have failed to address social cognitions as mediating variables in the environment-PA relationship.

When studying physical environmental influences on adolescent PA, most studies to date have focused on school environments (Ferreira, Van der Horst, Wendel-Vos, Kremers, Van Lenthe, and Brug 2005). Neighborhood influences have rarely been included in studies on adolescent PA (De Bruijn, Kremers, Wendel-Vos, Van Lenthe, and Brug, 2005; Duncan, Duncan, and Strycker, 2004), even though neighborhood influences such as attractiveness and proximity to local facilities have been found to be positively associated with PA in adults (Humpel, Marshall, Leslie, Bauman, and Owen, 2004; King, Castro, Wilcox, Eyster, Sallis, and Brownson 2000; Van Lenthe, Brug, and Mackenbach, 2005). The present study tested a conceptual model that explored the relative influences of past PA, neighborhood attractiveness, local facilities, and behavior-specific cognitions on current PA, using the theoretical tenets of the TPB.

METHODS

Data from the SMILE-study, an ongoing prospective cohort study, were analyzed. The SMILE-study is a joint project of Maastricht University and 23 General Practitioners (GPs) from nine Family Practice Centers (FPC) in Eindhoven, a city of approximately 200,000 inhabitants located in the southern part of the Netherlands. The distribution of gender and age in Eindhoven is similar to that of the Netherlands (Statistics Netherlands,

2002). The nine participating FPCs cover approximately 50,000 patients. All patients of 12 years and older registered at the participating FPCs are requested every six months to complete self-administered questionnaires that are sent to their home address. Participant addresses are obtained through the GPs. Anonymity is guaranteed and respondents are informed that GPs would not be notified about participation. The present analyses focus on adolescents aged 12 to 18 years. In line with informed consent regulations, only adolescents of whom informed consent was received from themselves and their parents were included in the present study. In May 2003 and November 2003, 476 (263 girls and 213 boys; mean age=15.0 years (SD=2.1)) and 507 (303 girls and 204 boys; mean age=14.9; SD=2.0) adolescents, respectively, completed these questionnaires. Respondents who completed both questionnaires ($n=221$; 51%) were included in the present study (88 boys and 133 girls; mean age=15.1 (SD=1.9)). Attrition analyses revealed no significant differences in age (OR=1.09; $p=.06$) and past PA (OR=1.00; $p=.53$) but boys were less likely (OR=.66; $p=.029$) to complete both questionnaires.

Measures

PA was assessed in May 2003 and November 2003, while environmental perceptions, behavior-specific cognitions, age and gender were assessed in November 2003. Based on a validated questionnaire for assessing adult PA (Ronda, Van Assema, and Brug, 2001), respondents were asked to indicate on how many days per week and for how many minutes per day they were engaged in walking, cycling, jogging, swimming, gymnastics, tennis, martial arts, field sports and skating. Multiplying frequency and time and dividing that score by 7 computed an average PA-score expressed in minutes per day. Five-point Likert scales were used to assess social cognitions and environmental perceptions. Attitude was assessed with two items, tapping the good-bad aspect (+2=very good; -2=very bad) and pleasant-unpleasant aspect (+2=very pleasant; -2 very unpleasant) regarding the statement 'I believe being physically active is'. Subjective norm was assessed with the item 'people who are important to me believe I should be physically active' on (+2=yes, definitely; -2=no, definitely not). PBC was assessed with two items regarding the able-unable aspect (+2=very sure I will be able; -2=very sure I will be unable) and the easy-difficult aspect (+2=very easy; -2=very difficult) of the preceding statement 'If I want to be physically active, I am / this will be'. Intention was assessed with the item 'I intend to be physically active in the next six months' (+2=yes, definitely; -2=no, definitely not). Based on Pikora and colleagues(2003) and empirical evidence (Van Lenthe, Brug, and Mackenbach, 2005), the environmental characteristics of aesthetics and availability of local

facilities were used as key indicators of physical environmental perceptions. Aesthetics were assessed with five items (my neighborhood is friendly; my neighborhood provides a pleasant living environment; my neighborhood is attractive; I feel safe when I am in my neighborhood; there is a lot of traffic in my neighborhood). Local facilities were assessed with two items (there are enough sport clubs in my neighborhood; there are enough opportunities for PA in my neighborhood). Respondents were asked to indicate to what extent they agreed (+2 = totally agree; -2 = totally disagree) with these statements. Additionally, an open item questioned respondents to indicate how far (in meters) they lived from the nearest opportunity to be physically active.

Data Analyses

Since Structural Equation Modeling (SEM) can be employed to test hypotheses about mediator variables (Masse, Dassa, Gauvin, Giles-Corti, and Motl, 2002), path analyses were performed using AMOS 4.0 (Smallwaters, Chicago IL, 1999). SEM allows for the assessment of overall model fit, the statistical significance tests for theorized relations in the model and the estimation of latent concepts free of measurement error. Since there were some missing responses (< 1%), full-information maximum likelihood (FIML) was used to estimate parameters. FIML is an optimal method for treatment of missing data (Kaplan, 2000) and has shown more accurate fit indices than pairwise deletion, listwise deletion or mean-imputation (Nunnally and Bernstein, 1994).

Based on the recommendations by Anderson and Gerbing (1988), a two-step procedure was followed. In the first step, Confirmatory Factor Analysis (CFA) was used to test an overall measurement model, consisting of four latent variables (i.e. attitude, PBC, aesthetics and local facilities) and five indicators (i.e. current PA, past PA, intention, subjective norm and distance to local facilities), which were allowed to correlate. For the latent variables, the loading of the first indicator was set to 1 in order to create its metric. The measurement model served as the baseline model for the path analyses in the structural model.

The fit of these models was evaluated using the chi-square goodness-of-fit test, which assesses the adequacy of the theorized model's covariance matrix in comparison with the observed covariance matrix. Since the chi-square test has been criticized for its dependence on sample size, including absolute and incremental fit indices is recommended (Hu and Bentler, 1999). The root mean square error of approximation (RMSEA) (Hu and Bentler, 1999) was used as an absolute fit index, while the NFI and CFI (Bentler, 1990) were used as indexes of incremental fit. An adequate model fit is

obtained when the NFI and CFI are greater than .90 and the RMSEA is equal to or less than .08 (Hu and Bentler, 1999), while a good model fit is obtained when the NFI and CFI are greater than .95 and the RMSEA is equal to or less than .05 (Hu and Bentler, 1999; Kline, 2005).

A stepwise procedure was followed in which nested models were tested. Based on the proposed relations in the TPB (Ajzen, 1991), the first model included (1) paths from past behavior and environmental variables to attitude, subjective norm and PBC; (2) paths from attitude, subjective norm and PBC to intention; (3) paths from intention and PBC to behavior (4) correlations between TPB cognitions and; (5) correlations between environmental variables. The second model differed from the first model by freeing the direct effect of past PA on current PA. The third model differed from the second model by freeing the effect of past behavior on environmental perceptions. The fourth model differed from the third model by freeing the direct effects of the environmental factors on current PA. Alternative models were compared with chi-square difference test. (Kline, 2005) Cohen's effect sizes (Cohen, 1988) were used as the informational source for the explanatory value of the model. The data analysis was conducted in 2005.

RESULTS

Descriptives

Mean total physical activity per day was 65.6 minutes (SD=50.6) and 72.7 minutes (SD=76.8) per day for current and past PA respectively (Table 7). Most common activities for past and current PA were cycling, field sports and gymnastics. Adolescents who were currently more physically active had a more positive attitude, perceived more behavioral control and less subjective norm towards being physically active. Additionally, they reported living further away from the nearest opportunity to be physically active.

Confirmatory factor analyses

The overall measurement model provided good fit to the data ($\chi^2 = 100.53$, $df=73$, $p=.02$; NFI=.97; CFI=.99; RMSEA=.04), but included two items ('there is a lot of traffic in my neighborhood'; 'there are enough sports clubs in my neighborhood') with inadequate ($< .40$) factor loadings. Deletion of these two items and re-estimating the measurement model provided good fit to the data ($\chi^2 = 64.40$, $df=47$, $p=.05$; NFI=.98; CFI=.99; RMSEA=.04) with all factor loadings $\geq .70$. Mean scores, standard deviations, factor loadings for the latent variables and interfactor correlations for the final measurement model are shown in Table 7.

Table 7. Mean scores, standard deviations, factor loadings (FL) for latent variables, and interfactor correlations from the overall measurement model

	Mean (SD)	Factorloading	1	2	3	4	5	6	7	8	9
1 Past PA	72.67 (76.81)		1								
2 Current PA	66.55 (50.61)		.37***	1							
3 Intention	.44 (1.14)		.04	.11	1						
4 Attitude			.17*	.31***	.58***	1					
<i>Good-bad</i>	1.26 (.67)	.72***									
<i>Healthy-unhealthy</i>	.95 (.82)	.88***									
5 Subjective norm	.19 (1.07)		-.04	-.14*	.29***	.10	1				
6 PBC			.26***	.23***	.34***	.50***	-.04	1			
<i>Able-unable</i>	.94 (.94)	.92***									
<i>Easy-difficult</i>	.56 (.98)	.76***									
7 Aesthetics			-.05	.03	.00	.18*	-.14	.00	1		
<i>Friendly</i>	.85 (.91)	.73***									
<i>Pleasant</i>	.85 (.94)	.92***									
<i>Attractive</i>	.44 (1.05)	.76***									
<i>Safe</i>	.73 (.92)	.70***									
8 Local facilities	.76 (.96)		.04	.01	-.02	.09	-.03	.07	.30***	1	
9 Distance to nearest PA opportunity	.250.99 (.551.99)		.06	.14*	.10	.15*	.00	.11	-.19**	-.33***	1

PA = physical activity; PBC = Perceived Behavioral Control

*** = $p < .001$; ** = $p < .01$; * = $p < .05$

Path analyses

Since our sample size was insufficient for latent variables (Bollen, 1989), path analyses were performed using observed variables. Mean scores for the multi-item scales of attitude, PBC and aesthetics were computed using SPSS Version 11.0.4 (SPSS Inc, Chicago IL, 2005). Internal consistency analyses revealed good psychometric properties (attitude: $\alpha = .77$; PBC: $\alpha = .82$; aesthetics: $\alpha = .86$). Mean score for attitude was 1.10 (SD = .80), for PBC .74 (SD = .89) and for aesthetics .72 (SD = .80).

Except for the RMSEA, the first model provided a good fit to the data ($\chi^2 = 47.32$, $df = 14$, $p < .001$; NFI = .97; CFI = .97; RMSEA = .10). The second model, where the direct effect of past PA on current PA was freed, resulted in a significantly better (χ^2 -difference = 26.3, $p < .001$) model fit ($\chi^2 = 21.02$, $df = 13$, $p = .07$; NFI = .98; CFI = .99; RMSEA = .05). The third model did not significantly improve model fit (past PA-aesthetics: χ^2 -difference = .53, $p = .467$; past PA-distance: χ^2 -difference = 1.16, $p = .281$; past PA-local facilities: χ^2 -difference = 1.21, $p = .281$). The fourth model also did not significantly improve model fit (aesthetics-PA: χ^2 -difference = .57, $p = .450$; distance-PA: χ^2 -difference = 1.46, $p = .227$; local facilities-PA: χ^2 -difference = .07, $p = .790$). Consequently, the second model provided the best fit to the data. The structure and path coefficients of this model are shown in Figure 7. Environmental aesthetics were a significant positive predictor of attitude ($\beta = .16$; $p = .02$), while distance to PA opportunities was a significant positive predictor of both attitude ($\beta = .19$; $p = .005$) and PBC ($\beta = .14$; $p = .04$). Past PA was a significant predictor of attitude ($\beta = .14$; $p = .03$), PBC ($\beta = .23$; $p < .001$) and current PA ($\beta = .34$; $p < .001$). Intention was most strongly influenced by attitude ($\beta = .45$; $p < .001$) and subjective norm ($\beta = .24$; $p < .001$). Intention did not significantly predict current PA. This final model accounted for a total of 34 percent of the variance in intention and 17 percent variance in current PA, indicating medium effect sizes.

DISCUSSION

In line with recent calls for advancing research methodologies and integrating theoretical approaches in the study of determinants of PA (Masse, Dassa, Gauvin, Giles-Corti, Motl, 2002; Owen, Humpel, Leslie, Bauman, and Sallis, 2004; Spence and Lee, 2003), the present study sought to identify determinants of adolescent PA by integrating relevant individual-level and environmental-level factors in a single study, using the theoretical relations of the TPB. Results regarding the individual-level factors showed that past PA was a significant unmediated predictor of current PA, replicating earlier findings in similar age groups (Hagger, Chatzisarantis, and Biddle, 2001; Hagger, Chazisarantis,

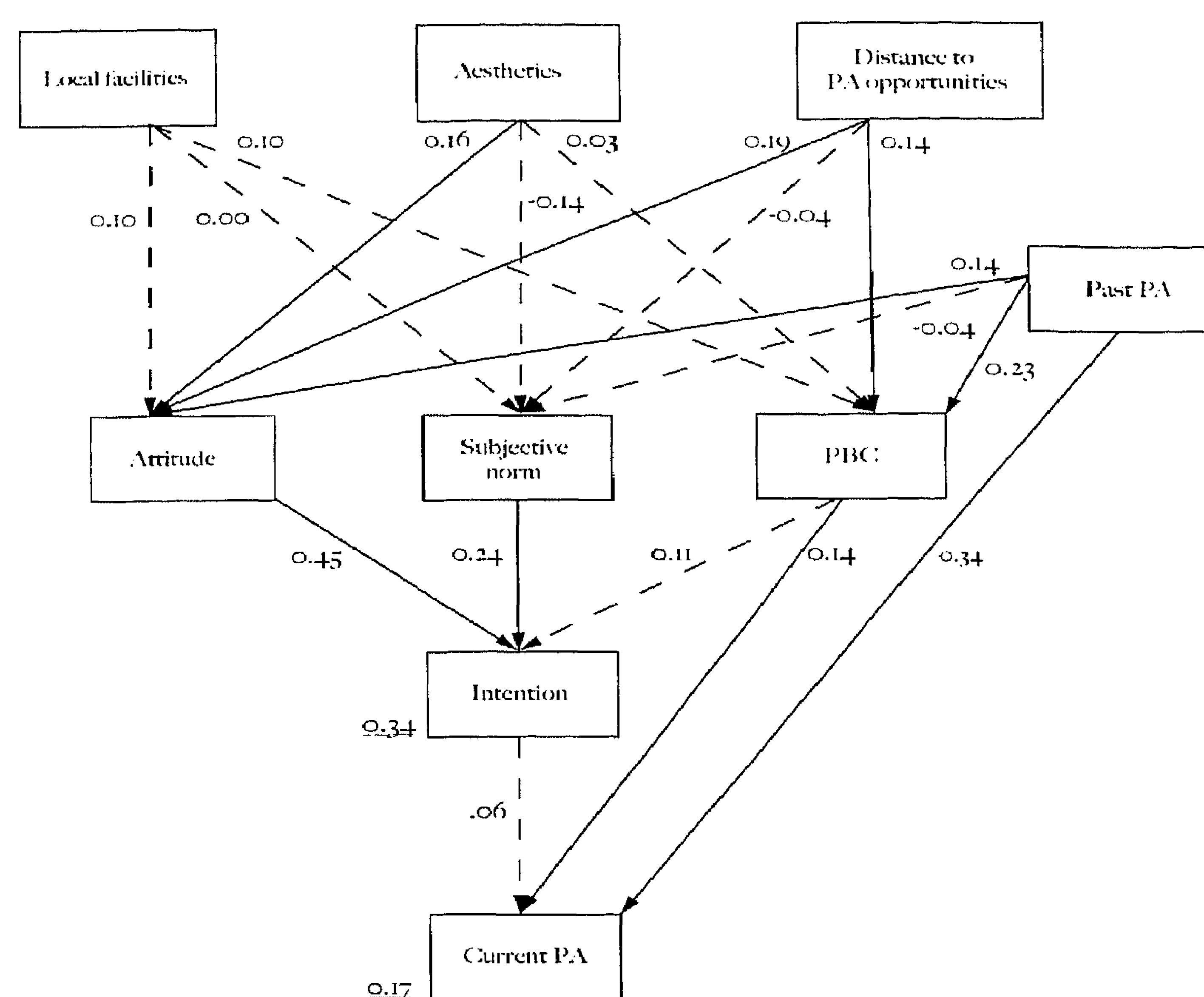


Figure 7: Standardized regression coefficients for final structural model. Solid lines indicate significant paths, dashed lines indicate non-significant paths. Underlined values indicate proportion explained variance. PA = Physical Activity; PBC = Perceived Behavioral Control
Model fit $\chi^2 = 21.02$, $df = 13$, $p = .07$; Normed Fit Index = .98; Comparative Fit Index = .99; Root Mean Square Error of Approximation .05.

Biddle, and Orbell, 2001). However, the direct influence of past behavior has frequently been dubbed an 'empty' concept (Ajzen, 1991; Eagly and Chaiken, 1993; Verplanken and Aarts, 1999). One of the mechanisms that may account for this direct influence is habit strength (Verplanken and Orbell, 2003). Empirical findings (Aarts, Paulussen, and Schaalma, 1997; Aarts, Verplanken, and Van Knippenberg, 1997) indicate additional explanatory value of habit in PA-related behaviors. While TPB-based interventions are generally based on informational strategies (i.e. providing people with information on health outcomes of being physically active), attitudinal and subsequent behavioral change will only occur if one is likely to pay attention to the new information (Chaiken, 1987).

Yet, research indicates limited and selective information processing when behavior is guided by strong habits rather than intentions (Aarts, Verplanken, and Van Knippenberg, 1997) and suggests that additional strategies beyond merely providing information are necessary (Kremers, Visscher, Brug, et al., 2005). Although using past behavior as a measure of habit strength has been criticized by Ajzen (Ajzen, 2002), Verplanken and Orbell (Verplanken and Orbell, 2003) have argued that habit is a psychological construct rather than mere past behavioral frequency and developed a script-based measure of habit to stimulate the further development of habit research and theory. Empirical evidence of this measure in determinant studies of adolescent PA is lacking, but since our results indicated that intention did not significantly influence PA, one may question the tenet that adolescent physical activity is largely explained by their personal motivation. Habit includes factors such as automaticity and unawareness (Verplanken and Orbell, 2003) and the inclusion of habit strength in future studies may provide a more sufficient account of the individual-level determinants of adolescent PA.

Regarding the environmental variables, freeing the direct effect of past PA on current environmental perceptions did not significantly increase model fit, suggesting that one's previous PA does not influence current environmental perceptions. Additionally, these environmental perceptions were not directly related to current PA, but adolescents who lived in a more attractive neighborhood had a more positive attitude towards being physically active. In contrast, adolescents who indicated that the nearest opportunity for PA was further away also had a more positive attitude and perceived more control towards being physically active. Since TPB-cognitions and environmental factors were assessed simultaneously in this study, this finding may reflect an inverse cause-effect relation. Those who perceived a greater behavioral control and who had a more positive attitude may have been more likely to seek out more convenient opportunities for PA, beyond the opportunities provided by their immediate neighborhood. Indeed, Bandura has conceptualized the influence of self-efficacy beliefs on one's perceptions of environmental barriers and opportunities (Bandura, 1986).

The present study is subject to certain limitations. First, the study cohort consisted of more females than the general Dutch population. Since females were also more likely to respond to both questionnaires, caution is needed to generalize findings. Second, although PA was assessed using frequency and duration for a wide range of common activities in Dutch adolescents, the questionnaire used was validated in an adult sample. Third, perceived environmental factors were used, as opposed to objective environmental factors. While a recent study (Hoehner, Brennan Ramirez, Elliot,

Handy, and Brownson, 2005) reported some similar associations between perceived and objective environmental factors with PA, little is known about the accuracy of such perceived environmental survey data (Kirtland, Porter, Abby, et al., 2003). As noted, self-efficacy beliefs influence environmental perceptions and underline the need for objective measurements in the study of environmental influences on PA. Finally, TPB cognitions were assessed with few and fairly crude items that did not fully comply with Ajzen and Fishbein's (1980) recommendations. Theoretically, PA should be considered as a behavioral category, rather than a single act (Ajzen and Fishbein, 1980; Kremers, Visser, Seidell, Van Mechelen, and Brug, 2005), and therefore cannot serve as an attitude object. However, considering the limited space available in the questionnaire and preventing questionnaires that are too long for adolescents to complete (Kremers, Visser, Seidell, Van Mechelen, and Brug, 2005), direct measures of cognitions regarding 'being physically active' were chosen.

In the past decades, the TPB has provided researchers with a plausible mechanism to account for reasoned action in PA, but many scientists agree that such a social-cognitive theory falls short of capturing all of the issues and domains that are specific to PA (King, Bauman, and Abrams, 2002). On the other hand, relatively broad conceptual models of putative environment-behavior relationships are currently being used to guide research (Owen, Humpel, Leslie, Bauman, and Sallis, 2004). For instance, in line with our results, a recent study (Craig, Brownson, Cragg, and Dunn, 2002) found environmental aesthetics to be unrelated to PA. Our results, however, showed that aesthetics had an indirect positive influence on adolescents' intention to be physically active, underlining the need for targeting both environments and individuals in order to increase current low activity levels. Future studies on PA determinants need to extend beyond behavioral sciences alone (King, Bauman, and Abrams, 2002) and include environmental factors and social cognitive factors in a single study (Kremers, Visser, Brug, et al., 2005; Owen, Humpel, Leslie, Bauman, and Sallis, 2004). Moreover, social cognitive factors should be used to test and explain the relationship between the physical environment and PA.

Part Two
Social Environmental Influences

Chapter 5

Associations of social-environmental and individual-level factors with adolescent soft drink consumption

Based on: G.J. de Bruijn, S.P.J. Kremers, H. de Vries, W. van Mechelen, and J. Brug (in press). Associations of social-environmental factors and individual-level factors with adolescent soft drink consumption: Results from the SMILE-Study. Health Education Research

ABSTRACT

Background: Adolescent obesity is positively associated with soft drink consumption. We investigated the association of social-environmental and individual-level factors with soft drink consumption in a Dutch adolescent sample.

Methods: Data were gathered in a longitudinal Dutch adolescent sample ($n = 208$; 62% girls). Soft drink consumption, social cognitions from the Theory of Planned Behavior and parenting practices towards limited soft drink intake, and Big Five personality dimensions were assessed. Data were analyzed using three-step linear regression analyses. Effect sizes were used as the informational source for the explanatory value of the model. Interaction terms were computed to test the individual-environment interaction.

Results: Attitude and subjective norm were significantly associated with soft drink consumption. When controlling for social cognitions, the distal variables parenting practices and the personality dimension Agreeableness remained significantly associated with soft drink consumption. Agreeableness moderated the association of parenting practices with adolescent soft drink consumption. Standardized regression coefficients ranged from .16 to .24 and explained 14 percent of the variance in soft drink consumption, indicating a medium effect size.

Conclusions: Stricter parenting practices were associated with less soft drink consumption and these effects were moderated by adolescent personality. The direct effects of practices and personality are noteworthy from a theoretical perspective.

Implications for obesity prevention interventions are discussed.

INTRODUCTION

Adolescent overweight and obesity prevalence rates are increasing in many countries (Bundred, Kitchiner, and Buchan, 2001; Janssen, Katzmarzyk, and Boyce, 2004; Ogden, Flegall, Carroll, et al., 2002) and present a major public health problem because of its association with cardiovascular disease risk factors, type 2 diabetes (Freedman, Khan, Dietz, et al., 2001; Garrison, Higgins, and Kannel, 1996; Goran, Ball, and Cruz, 2003; Must and Strauss, 1999; Sinha, Fisch, Teague, et al., 2002) and psychosocial problems (Gortmaker, Must, Perrin, et al., 1993; Needham and Crosnoe, 2005; Pierce and Wardle, 1997). Additionally, obese youth tend to become obese adults (Guo, Wu, Chumlea, et al., 2002; Whitaker, Wright, Pepe, et al., 1997). Although genetic factors are involved in the individual onset of obesity, they are not likely to be the main cause of its increasing prevalence in the last decades (Hill, 1998). Weight gain occurs as a result of a positive energy balance, in which the energy intake (through diet) exceeds energy expenditure (mainly through physical activity) over a period of time. Thus, the increase in overweight and obesity prevalence rates in the last decades is largely behavior related. Although evidence for specific behavioral factors that promote or protect against weight gain in children is more limited than in adults (Rennie, Johnson, and Jebb, 2005), several behaviors have been identified, such as lack of physical activity, sedentary behavior and the consumption of energy-dense snacks (Hill, 1998; Kremers, Visscher, Brug, et al., 2005). Additionally, consumption of sugar-sweetened soft drink may promote weight gain in youngsters (James, Thomas, Cavan, et al., 2004; Ludwig, Peterson, and Gortmaker, 2001; World Health Organization, 2003). Although the association between weight gain and soft drink consumption is still debated (Berkey, Rockett, Field, et al., 2004; Forshee, Anderson, and Story 2004; French, Hannan, and Story, 2004), soft drink consumption may have additional health consequences such as a decreased intake of milk and nutrients (Guenther, 1986) and caries (Jarvinen, Rytomaa, and Heinonen, 1991). Hence, reducing adolescent soft drink consumption may be an important way to improve adolescent health.

When developing behavioral change interventions, insight into the behavioral determinants is needed (Baranowski, Cullen, Nicklas, et al., 2003). Traditionally, health behavior research has focused on identifying individual psychosocial determinants such as those used in the Theory of Planned Behavior (TPB) (Ajzen, 1991). The TPB proposes that behavior is determined by one's intention to perform that particular behavior. In turn, the intention is determined by three psychosocial concepts, namely attitude, subjective norm and perceived behavioral control (PBC). The TPB is theorized to be a comprehensive model for explaining and predicting health behavior, since extraneous or

distal variables, such as the physical environment, the social context and personality, are thought to influence health behavior through these social cognitions (Ajzen, 1991; Rhodes, Courneya, and Jones, 2004). However, recent studies suggest that the TPB is unable to fully account for such distal, relatively stable influences (Conner and Abraham, 2001; Courneya, Bobick, and Schinke, 1999; De Bruijn, Kremers, Schaalma, Van Mechelen, and Brug, 2005). Consequently, (social) ecological models are increasingly being suggested to gain more insight into the influence of the social and physical environment on health behavior (Egger and Swinburn, 1997). Ecological models specify that distal individual-level factors interact with (social) environmental factors to influence health behavior. Moreover, distal factors are hypothesized to directly affect health behavior, thereby bypassing the proximal cognitive factors. In the present study, we investigated individual-level and social-environmental factors associated with adolescent soft drink consumption.

One of the most influential social-environmental factors for adolescents are their parents (Baranowski, 1997), who play an important role in adolescents' health behaviors (Kodl and Mermelstein, 2004; Trost, Sallis, Pate, et al., 2003; Young, Fors, and Hayes, 2004). A type of parental influence that is receiving increased scientific attention is parenting practices (Huver, Engels, and De Vries, 2006; Borawski, Ievers Landis, Lovegreen, et al., 2003; Spruijt Metz, Lindquist, Birch, et al., 2002). In contrast to general parenting styles, practices refer to content-specific acts of parenting (Darling and Steinberg, 1993). Parents may try to influence their children's food intake by setting house rules: telling their children what to eat and when to eat it when they are at home. Child-feeding practices may be regarded as an environmental factor in childhood and adolescent obesity (Birch and Fisher, 1998) and the effects of those practices have been studied in relation to various health behaviors (Huver, Engels, and De Vries, 2006; De Bourdeaudhuij, 1997; De Bourdeaudhuij and Van Oost, 2000; Fisher and Birch, 1999a; Fischer and Birch, 1999b; Jackson and Henriksen, 1997). However, those studies have yielded mixed results, with strict practices having either a positive or negative effect on adolescent health behavior. These adverse results suggest that additional factors may moderate the influence of practices. For instance, the contextual influence of a general parenting style is assumed to moderate the association between parenting practices and adolescent outcomes (Darling and Steinberg, 1993). Beyond additional social-environmental factors, individual-level factors may also influence the association between parenting practices and adolescent outcomes. Indeed, in Darling and Steinberg's theoretical model on parental influences, adolescent personality is theorized to moderate

the association between practices and adolescent outcomes. However, empirical studies that investigate such moderating factors are lacking. Thus, there is a need to further investigate how individual-level factors, i.e. adolescent personality, interact with social-environmental factors, i.e. parenting practices, and subsequently influence adolescent health behavior.

In current personality research, consensus has emerged on the structure of personality, which can be adequately described in terms of five broad dimensions (Goldberg, 1990). These dimensions are commonly labeled Conscientiousness, Agreeableness, Extraversion, Emotional Stability and Openness to Experience and appear universal across cultures (Jang, McCrae, Angleitner, et al., 1998) and robust irrespective of language, factor analytical techniques and method of assessment (De Raad, Perugini, Hrebickova, et al., 1998; Goldberg, 1990; McCrae and John, 1992). Empirical evidence indicates that these dimensions are associated with health behavior in both adolescents and adults (Bermudez, 1999; Booth-Kewley and Vickers, 1994; Courneya and Hellsten, 1998; De Bruijn, Kremers, Van Mechelen, and Brug, 2005; Ingledew, Markland, and Sheppard, 2004; Lemos-Giraldez and Fidalgo Aliste, 1997). Moreover, the direct effects of these personality dimensions are found even when controlling for social cognitions and intention (Conner and Abraham, 2001; Courneya, Bobick, and Schinke, 1999; Rhodes, Courneya, and Jones, 2004) and suggest combining personality and social cognitions may provide a more sufficient account of the determinants of health behavior (Conner and Abraham, 2001).

The purpose of the present study is two-fold. First, we investigated the influence of the distal variables adolescent personality and parenting practices with adolescent soft drink consumption. Based on the proposed theoretical relations of the TPB (Ajzen, 1991), we hypothesized that the influences of personality and parenting practices on adolescent soft drink would be mediated by behavior-specific cognitions and intention. Second, we investigated if adolescent personality moderated the association between practices and adolescent soft drink consumption.

METHODS

Subject and procedures

For the present study, data from the Study on Medical Information and Lifestyle in Eindhoven (SMILE), an ongoing prospective cohort study, were analyzed. This study is a joint project of Maastricht University and 23 General Practitioners (GPs) from nine Family Practice Centres in Eindhoven, a city of approximately 200,000 inhabitants

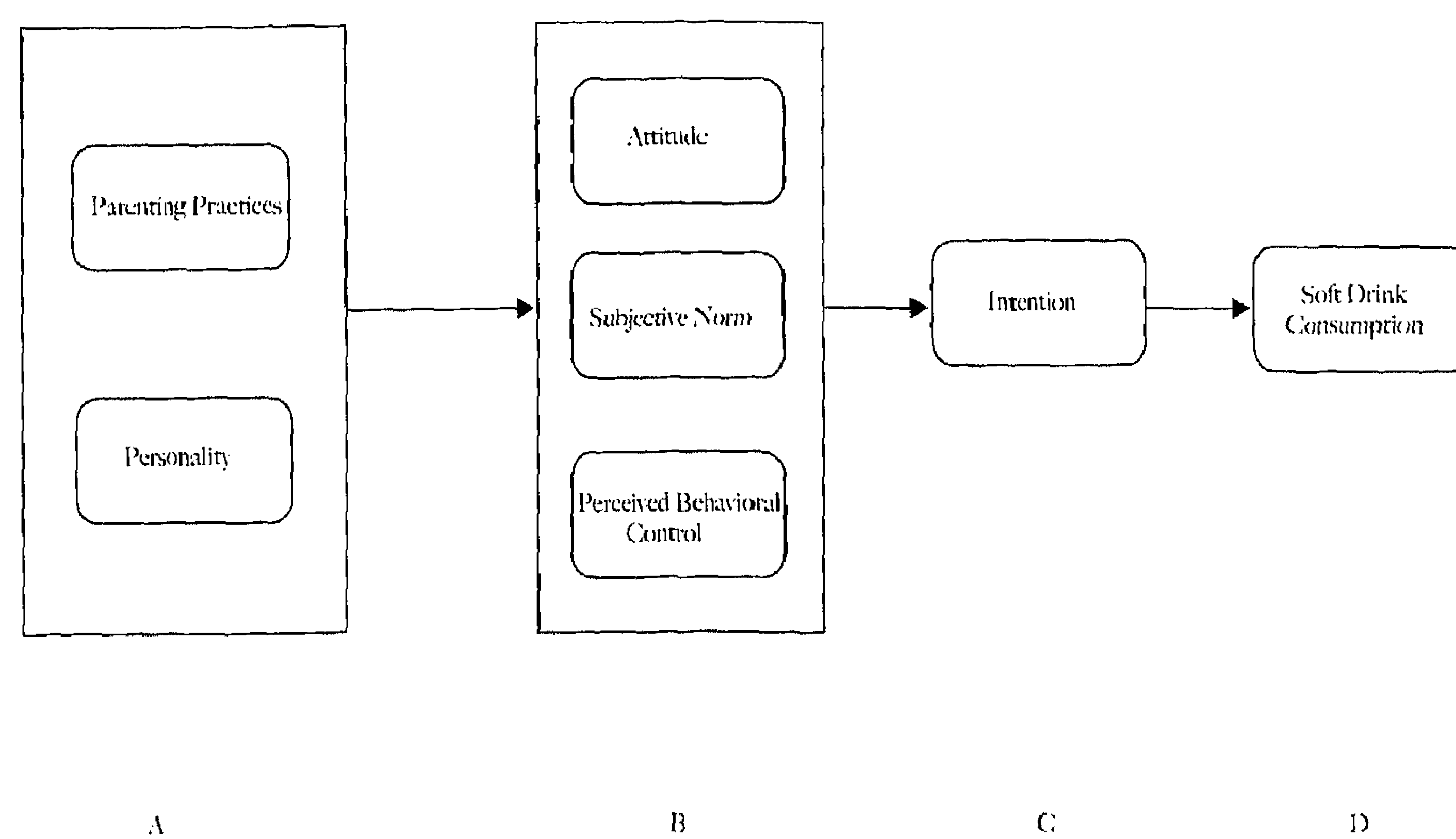


Figure 8. Theorized relations between parenting practices, personality and TPB variables in the Theory of Planned Behavior

located in the southern part of the Netherlands. All patients of 12 years and older registered at those GPs are requested every six months to complete self-administered questionnaires at home. Anonymity is guaranteed and participant addresses were obtained through the GPs. Respondents were informed that GPs would not be notified about participation. For respondents in the age bracket 12 to 18, informed consent is required from both the respondent and their parents. Only those adolescents of whom informed consent was received from themselves and their parents were included in this study. In addition to the questionnaire sent, an explanatory covering letter and a reply-paid envelope was included. In case of non-response to the initially mailed questionnaire, a reminder was sent two weeks later.

In May 2003 and November 2003, 12-to-18-year-olds were asked to complete a self-administered questionnaire at home. In May 2003 and November 2003, 476 (263 girls and 213 boys; mean age = 15.0 years ($SD = 2.1$)) and 507 (303 girls and 204 boys; mean age = 14.9; $SD = 2.0$) adolescents, respectively, completed these questionnaires. Respondents who completed both surveys ($n = 241$; 51%) were included in the present study. Deletion of cases with missing values on key variables left a total sample of 208 (80 boys and 128 girls; mean age = 15.2 ($SD = 1.9$)). Attrition analyses showed that girls

were more likely ($OR=1.6$; $p=.017$) to respond to both questionnaires. No significant differences for drop-out were observed for age and personality dimensions.

Measures

Big Five personality measures were assessed in the May 2003 questionnaire, while measures of soft drink consumption, soft drink related cognitions and parenting practices, and demographics were assessed in the November 2003 questionnaire. Based on a validated questionnaire for dietary intake (Bogers, Brug, Van Assema, et al., 2004; Van Assema, Brug, Ronda, et al. 2002), soft drink consumption was assessed by asking respondents to indicate on how many days a week (range: never – 7 days per week) they drank sugar-containing soft drinks, such as regular cola and Sprite. Additionally, respondents were asked to indicate how many glasses (150 ml), cans (330 ml) and/or bottles (500 ml) they drank on such a day. Multiplying frequency and usual amount and dividing that score by 7 computed an average score for consumed soft drinks in millilitres per day.

Intention was assessed by the item 'I intend to consume a limited amount of soft drink in the next six months' on a five-point Likert scale (+2=yes definitely; -2=no definitely not). Attitude was measured as the average of two items ($\alpha=.59$) on five-point Likert scales assessing the good-bad aspect (+2=very good; -2=very bad) and the pleasant-unpleasant aspect (+2=very pleasant; -2=very unpleasant) of the preceding statement 'I believe consuming a limited amount of soft drink is'. Subjective norm was measured as the average of two items ($\alpha=.63$) on five-point Likert scales (+2=yes definitely; -2=no definitely not) regarding parents and peers (my parents/peers think I should consume a limited amount of soft drink). PBC was measured as the average of two items ($\alpha=.80$) on five-point Likert scales assessing the easy-difficult aspect (+2=very easy; -2=very difficult) and the succeed-fail aspect (+2=very likely to succeed; -2=very likely to fail) of the preceding statement 'When I want to limit the amount of soft drink I consume, this will be/ I think I will be'.

Based on previous work by Cullen and colleagues (2001), we assessed parenting practices with 8 items ($\alpha=.87$) regarding soft drink consumption. Respondents were asked to indicate on a five-point Likert scale to what extent they agreed (0=totally agree; 5=totally disagree) with such statements as 'my mother/father tells me what kind of soft drink I am allowed to consume; my mother/father tells me how much soft drink I may consume; my mother/father tells me when I may drink soft drink; my mother/father allows me to drink soft drink in the weekend'. A total score was computed by summing

the scores in such a way that a higher score meant respondents perceived more strict practices. Big Five dimensions were assessed using a shortened version of a Dutch translation of Goldberg's adjective 100 list (Gerris, Houtman, Kwaaitaal-Roosen, et al., 1998) that has shown good reliability in 12-to-18-year olds (Scholte, Van Aken, and Van Lieshout, 1997). Respondents indicate on a 7-point scale to what extent they agreed (0 = totally disagree; 7 = totally agree) with such statements as 'I am creative; I am quiet; I am helpful; I am careless'. Internal consistency analyses revealed good psychometric properties (Extraversion $\alpha = .83$; Agreeableness $\alpha = .80$; Conscientiousness $\alpha = .84$; Emotional Stability $\alpha = .81$; Openness to Experience $\alpha = .72$). Scale scores were computed by summing the scores on the respective scales.

Analyses

Spearman (gender) and Pearson correlations were computed. Additionally, scores for the study variables were checked for normal distributions using tests for skewness and kurtosis (Tabachnick and Fidell, 2000). Second, based on the recommendations by Fox (1991), regression diagnostics for outliers were conducted. Influence scores were investigated using Cook's distance (Cook, 1977), with cases in which Cook's distance is larger than 1 indicative of outliers.

In order to test the hypothesis that social-cognitive factors would mediate the effect of parenting practices and personality on adolescent soft drink consumption we followed a stepwise approach based on the recommendations by Baron and Kenny (Baron and Kenny, 1986). In the first step, parenting practices and personality must be associated with the social-cognitive variables studied (A-B; see Figure 1). In the second step, parenting practices and personality must be associated with soft drink consumption (A-D). Thirdly, social-cognitive factors must be associated with intention (B-C) while in the fourth step intention must be associated with soft drink consumption (C-D). The final step tests if the association between parenting practices and personality with soft drink consumption (A-D) is reduced when the social-cognitive variables and intention are added to the model. In the case of perfect mediation, the effect of parenting practices and personality will become zero. If the effect of parenting practices and personality with soft drink consumption reduces but remains statistically significant, social-cognitive variables are partial mediators. In case of a significant association between one or more personality dimensions with soft drink consumption, the other personality dimensions were additionally controlled for in the final multivariate regression analysis. Finally, if age and/or gender were significantly associated with soft drink consumption in the univariate

analysis, we adjusted for these demographics in the multivariate analysis.

We used the magnitude of the effect size as a source of information for the explanatory value of the full model. Effect sizes (f^2) were computed by dividing the amount of explained variance (r^2) by the amount of error variance ($1-r^2$). Based on Cohen's descriptive guidelines (Cohen, 1988), effect sizes were regarded as small when f^2 was between .02 and .15, medium for f^2 between .15 and .35 and large when f^2 was equal to or larger than .35. In case of significant main effects for personality dimensions and parenting practices, interaction terms were computed. In order to investigate both linear and curvilinear relationships, we entered a linear and quadratic interaction term in the final block.

RESULTS

Univariate analyses

Mean and median intake of soft drink was, respectively, 479.9 ml (SD=499.5) and 342.9 ml per day (Table 8). Forty-three percent indicated to consume at least one can of soft drink on every day of the week. Those who consumed more soft drink had a more negative intention and attitude towards limited soft drink consumption. Additionally, they perceived less behavioral control and parenting practices regarding soft drink consumption.

Multivariate analyses

Normality analyses revealed that soft drink consumption, subjective norm and attitude moderately differed from normality and were subsequently transformed using square root transformation (Tabachnick and Fidell, 2000). After transformation, acceptable normal distributions were obtained. Furthermore, regression diagnostics revealed no cases with an undue influence on regression estimates, with Cook's distance ranging from .000 to .071. Regarding the mediator analyses, the first step showed that parenting practices were significantly associated with subjective norm ($\beta = .21$; $p = .003$). Additionally, the personality dimension Agreeableness was associated with subjective norm ($\beta = -.12$; $p = .084$). In the second step, parenting practices ($\beta = -.22$; $p = .002$) and Agreeableness ($\beta = .13$; $p = .054$) were associated with soft drink consumption. The third step showed that attitude ($\beta = .32$; $p < .001$), subjective norm ($\beta = .22$; $p = .001$) and PBC ($\beta = .16$; $p = .015$) were significantly associated with intention, while in the fourth step, intention was significantly associated with soft drink consumption ($\beta = -.20$; $p = .003$). In the final step, all variables were simultaneously regressed on soft drink consumption (Table 9). When controlling

Table 8. Mean scores, standard deviations and bivariate correlations for study variables

		Mean (SD)	1	2	3
1	Soft drink	479.86 (499.53)	1		
2	Intention	-.52 (1.10)	-.20**	1	
3	Attitude	.24 (.57)	-.23**	.38***	1
4	Subjective Norm	-1.04 (.85)	.03	.23**	.04
5	Perceived Behavioral Control	1.03 (.97)	-.16*	.19**	.21**
6	Parenting Practices	16.45 (6.93)	-.26**	.10	.02
7	Extraversion	29.43 (6.74)	-.04	.03	.01
8	Agreeableness	33.34 (4.34)	.07	-.02	.05
9	Conscientiousness	25.77 (6.89)	.05	.05	-.03
10	Emotional Stability	25.76 (6.55)	-.05	-.03	-.05
11	Openness to Experience	28.50 (5.58)	-.05	.01	.00
12	Age	15.20 (1.88)	-.03	.01	.18**
13	Gender (1 = boy, 2 = girl)		.13	-.11	.06

*** p < .001; ** p < .01; * p < .05

Chapter 5

	4	5	6	7	8	9	10	11	12	13
1										
-.10	1									
.21**	-.01	1								
.05	.06	.01	1							
-.09	.05	-.02	.39**	1						
-.07	.11	-.11	-.23**	.10	1					
.01	.03	-.03	.33**	.03	.03	1				
.00	.09	-.03	.25**	.35**	-.09	-.02	1			
.20**	.19**	-.26**	-.05	-.08	.14*	.00	.05	1		
-.16*	.02	.08	-.22**	.02	.04	.04	-.08	-.01	1	

Parenting practices, adolescent personality and soft drink consumption

for the influences of parenting practices, personality and social-cognitive variables, intention was no longer significantly associated with soft drink consumption. Moreover, the effects of parenting practices and Agreeableness were largely unmediated by social-cognitive variables. Those who perceived more parenting practices towards limited soft drink consumption, were less Agreeable, had a more positive attitude and perceived less subjective norm towards limited soft drink consumption drank less soft drink. The final model explained 14% of variance in adolescent soft drink consumption ($F^2 = .16$), indicating a medium effect size.

Table 9: Standardized regression coefficients, p-values and explained variance from regression analysis for soft drink consumption (n = 208)

Predictor variable	β	R^2	β	R^2	β	R^2
Parenting practices	-.24***	.14	-.25***	.14	-.22**	.16
Extraversion	-.11		-.10		-.09	
Agreeableness	.16*		.18		.17*	
Conscientiousness	.00		.01		.02	
Emotional Stability	.01		.01		-.01	
Openness to Experience	-.08		-.09		-.08	
Attitude	-.24**		-.24**		-.26***	
Subjective Norm	.20**		.20**		.19**	
Perceived Behavioral Control	-.04		-.04		-.02	
Intention	-.12		-.12		-.11	
Linear interaction			.07		.02	
Quadratic interaction					.15*	

*** $p < .001$; ** $p < .01$; * $p < .05$

Moderator analyses

Since the final step in the multivariate analyses showed that parenting practices and Agreeableness had significant main effects on adolescent soft drink consumption, we computed a linear and a quadratic interaction term with those factors in order to investigate the potential moderating role of this personality dimension. We followed the recommendation of Aiken and West (1991) to mean-center the constituent interaction

variables in order to minimize problems with multi-collinearity. First, the linear interaction was added in the second step to the final model of the regression model. Secondly, the quadratic interaction term was entered in the third step. Table 2 shows that the quadratic interaction term was statistically significant, indicating a curvilinear relationship regarding the moderating effect of personality on the practices-behavior relationship. We therefore performed stratified analyses based on validated cut-off points for Agreeableness (Gerris, Houtmans, Kwaaitaal-Roosen, et al., 1998): those with scores lower or equal to 32 were classified as low ($n=73$), those with scores between 32 and 36 were classified as medium ($n=59$) and those with scores equal to or higher than 36 were classified as high ($n=76$). The effect of parenting practices on soft drink consumption was most pronounced ($\beta=-.28$; $p=.041$) in adolescents with moderate levels of Agreeableness. The effect of parenting practices for adolescents with either low or high levels of Agreeableness were smaller in effect and non-significant ($\beta=-.17$, $p=.145$ and $\beta=-.18$; $p=.129$, respectively).

DISCUSSION

In the present study, we investigated the association between parenting practices and Theory of Planned Behavior variables with adolescent soft drink consumption. Results showed that adolescents who perceived more strict practices towards soft drink intake consumed less soft drink. Notably, this effect was largely unmediated by social cognitions and intention. Moreover, results indicated that the effect of strict parenting practices was moderated by the adolescent personality dimension Agreeableness, with strict practices being most effective in adolescents with moderate levels of Agreeableness. Adolescents with low levels of Agreeableness appear less willing to obey parental practices, reflecting Darling and Steinberg's theoretical model (Darling and Steinberg, 1993). This model postulates that adolescent's 'willingness to be socialized', a concept that bears resemblance to the personality dimension Agreeableness, is a moderator of the relationship between parenting practices and adolescent outcomes. In contrast to the linear relationship theorized by Darling and Steinberg, our results are not consistent with a linear relationship but may indicate a curvilinear relationship. For adolescents with high levels of Agreeableness, this may reflect compliance (as opposed to internalization) in the home setting, but opposite behavior in a different setting. Indeed, Fisher and Birch found that parental restriction to palatable foods can actually promote the intake of these foods in an unrestricted situation, for instance when parents are absent (Fisher and Birch, 1999).

Previous studies on personality and diet have generally found positive health

effects of Agreeableness (Booth-Kewley and Vicker, 1994; De Bruijn, Kremers, Van Mechelen, and Brug, 2005; Lemos-Giraldez and Fidalgo Aliste, 1997). Our results indicate, however, that more agreeable adolescents engaged in unhealthy behavior, i.e. consumed more soft drink. Since individual-level factors are thought to interact with environmental factors (Duncan, Duncan, Strycker, et al., 2004), individual-level factors may thus be health beneficial in some environments (for instance the home environment), but these same individual-level factors may be health detrimental in others. Nowadays, soft drink vending machines are widely available at schools (Story, Hayes, and Kalina, 1996) and in those environments peer influences may be stronger than parental influences. Since peer influences have been found to be positively associated with adolescent soft drink consumption (Grimm, Iarnack, and Story, 2004) and because Agreeableness is linked to prosocial motives, those high on Agreeableness may be more likely to comply with those peer influences and, consequently, have higher soft drink consumption. This may be even more pronounced, since parents tend to view the issue of soft drink vending machines as a matter of personal choice for their children (Hendel Paterson, French, and Story, 2004). An additional explanation might be related to marketing: soft drink companies increasingly use adolescent-targeted advertisements and marketing through the use of prototypes. According to Gibbon's Prototype/Willingness Model (Gibbons, Gerrard, Ouellette, et al., 2000) of adolescent health-risk behavior, prototypes influence health-related behaviors through the process of social comparison (Festinger, 1954). Adolescents with high level of Agreeableness may be more sensitive to social comparison and therefore more inclined to live up to expectations raised by prototype-based advertisements and marketing. Indeed, a recent study found social comparisons to be of particular interest in the relation between media images and body dissatisfaction (Tiggeman and Slater, 2004) while Ravis and Sheeran (2003) found prototype similarity to be positively associated with health behavior.

Individual-level factors in health education research are generally limited to social cognitions, most likely because these are modifiable through interventions (Glanz, Rimer, and Lewis, 2002) and assumed to be under conscious control (Bargh and Chartrand, 1999; Jeffery, 2004). According to the TPB, the influence of personality factors is mediated by social cognitions. Hence, one may argue that those with high levels of Agreeableness are, for instance, more likely to perceive more subjective norm and, consequently, intend and act on these subjective norms. However, the present study and other recent studies (Courneya, Bobick, and Schinke, 1999; Rhodes, Courneya, and Jones, 2004) indicate that these personality influences on health behavior are largely

unmediated by social cognitions and thus pose a theoretical threat to the TPB. It has been argued that social cognitions lack temporal stability in measurement (Conner and Abraham, 2001; Rhodes, Courneya, and Jones, 2004), which Ajzen (Ajzen, 2002) acknowledged to be a limitation of the TPB. Intentions have been found to be unstable even over a 2-day duration (Courneya and McAuley, 1993). Despite these findings, social cognitions are still the predominant individual-level factors in health education research. However, the inclusion of more stable and global individual dispositions, such as personality, may allow us to gain a better understanding of the determinants of current health behavior, but may also prove helpful in predicting future health behavior. Importantly, our results indicate that adolescent personality influences may provide an explanation for the mixed effects of parenting practices on adolescent health behavior.

Regarding social cognitions, attitude and subjective norm were significantly associated with soft drink consumption. For subjective norm, counter-theoretical results were found: adolescents who perceived stronger subjective norm to limit their soft drink consumption actually consumed more soft drink. This may, however, reflect the cross-sectional nature of our study: those already consuming higher amounts of soft drink may, as a result, perceive stronger subjective norm to limit their intake. Additionally, both intention and PBC did not add significantly to the explanation of adolescent soft drink consumption when parenting practices were taken into account. While intention was significantly associated with soft drink consumption in the univariate analysis, this was no longer the case when parenting practices, personality dimensions and social-cognitive variables were controlled for. This finding may underline the central role parents can play in adolescents' health-related behaviors, such as soft drink consumption. The present study indicated that a one unit increase on the parenting practices scale would result in a decrease of 39 millilitre soft drink consumption per day. Based on 37 kilocalories per 100 millilitre soft drink consumption (Stichting NEVO, 2001), such a decreased consumption may, if energy intake and expenditure from other sources remain constant, result in a .83 kg weight loss in adolescents over a one-year period (American College of Sports Medicine, 1995).

A few limitations of our present study need commenting. First, respondents in our study were not representative for the total Dutch adolescent population, with a larger proportion of females than the Dutch adolescent population at large. Additionally, response rate was below 20 percent (De Bruijn, Kremers, Van Meehelen, and Brug, 2005) and since females were more likely to respond, caution is needed to generalize findings. Also, soft drink consumption has been found to be associated with socio-

economic status (Vereecken, Inchley, Subramanian, et al., 2005) and since no information on socio-economic status was available, we could not control for such factors. Second, our model was able to explain only 14 percent variance in soft drink consumption. Recent TPB reviews (Armitage and Conner, 2001; Godin and Kok, 1996) show the TPB is capable of accounting for some 30 to 40 percent of the variance in self-reported behavior. Moreover, these reviews indicate that intention is the most important variable in the TPB, accounting for two-thirds of the total explained variance in health behavior. Since adolescent soft drink consumption appears to be a behavior not largely determined by intention, explanatory power of our model may have been hampered. Third, although our results indicate that the mixed effects of parenting practices on adolescent health behavior might be attributed to adolescent personality influences, other studies have suggested that additional social-level factors may play a role. For example, a recent study (Kremers, Brug, De Vries, and Engels, 2003) suggested that these mixed results might also be attributed to the contextual influence of a general parenting style. Additionally, peer influences have been found to be positively associated with adolescent soft drink consumption (Grimm, Harnack, and Story, 2004). Thus, further research is warranted to understand how individual-level factors interact with other social-environmental factors and subsequently influence health behavior. Finally, we assessed social cognitions with only a few items. From both a theoretical and practical perspective, this may seem plausible and preferable (Kremers, Visser, Seidell, et al., 2005). Nevertheless, internal consistency values are highly dependent upon the number of items in a scale (Streiner and Norman, 2003) and the modest psychometric properties for attitude and subjective norm may have limited their mediating capacities.

Environmental influences are thought to play an important role in the current obesity epidemic (Hill, 1998; Goran, 2000). Although the TPB postulates that these influences are mediated by PBC and intention, the present study and other recent studies (Courneya, Bobick, and Schinke, 1999; De Bruijn, Kremers, Schaalma, et al., 2005) indicate that the TPB is inadequate to fully account for such influences. In addition, TPB-based interventions are not always successful in inducing behavioral change (Hardeman, Johnston, Johnston, et al., 2002), which may be a result of the direct influence of social and physical environmental factors on health behavior. Moreover, the apparent lack of intentional action in adolescent soft drink consumption necessitates focusing on environments instead of on cognitions in health behavior interventions (Kremers, Visser, Brug, et al., 2005). Indeed, (social) ecological models look promising for obesity prevention (Baranowski, Cullen, Nicklas, et al., 2003). Consequently, interventions aimed

at preventing weight gain are likely to be more effective if the direct influences of the physical and social environment are taken into account (Kremers, Visser, Brug, et al., 2005).

Chapter 6

Modeling sources and types of social support, and situation-specific self-efficacy with adult moderate and vigorous physical activity

de Bruijn, G.J., S.P.J. Kremers, G. Lensvelt-Mulders, L.J.J. Koppes, H.C.G. Kemper, W. van der Pijl, and J. Brug. Modeling sources and types of social support, and situation-specific self-efficacy with adult moderate and vigorous physical activity. (submitted)

ABSTRACT

The purpose of this cross-sectional study was to test a conceptual model that examined the relative associations of different sources and types of social support (i.e., encouragement, informational, emotional, and instrumental support) and situational-specific self-efficacy constructs regarding physical activity with adult moderate (model 1) and vigorous (model 2) physical activity, based on proposed relations in Social Cognitive Theory. Data were available from 431 respondents (mean age = 32.37, SD = .89; 234 females) in the 1996/1997 follow-up of the Amsterdam Growth And Health Longitudinal Study. Social support and self-efficacy were assessed using self-administered questionnaires. Levels of moderate and vigorous physical activity were assessed in a face-to-face interview. Results from path analyses revealed different associations between sources and types of social support with different physical activity intensity levels. Self-efficacy partly mediated these influences for vigorous, but not for moderate physical activity. It is concluded that different sources and types of social support operate for different intensity levels of physical activity and the importance of self-efficacy increases with level of physical activity intensity. Longitudinal research is needed to support these findings and additional cognitive mediators should be investigated.

INTRODUCTION

Results indicate that the majority of adults do not meet the recommended guidelines for physical activity (U.S. Department of Health and Human Services, 1996). Since regular physical activity is protective against a wide range of medical conditions (Kromhout, Bloemberg, Seidell, Nissinen, and Menotti, 2001; U.S. Department of Health and Human Services, 1996), effective interventions to increase physical activity levels amongst adults are urgently needed. When developing behavior change interventions, insight into the determinants of those behaviors is needed. Traditional determinant research has focused on identifying intrapersonal psychosocial determinants related to physical activity (Armitage, 2005; Hagger, Chatzisarantis, and Biddle, 2002), but the importance of environmental influences on physical activity has been highlighted in recent years (Pikora, Giles-Corti, Bull, Jamrozik, and Donovan, 2003; Spence and Lee, 2003). The evidence regarding the association between physical environmental factors and physical activity, however, is inconsistent (Brug and Van Lenthe, 2005). Importantly, influences from the social environment may be more relevant to physical activity than physical environmental influences (Giles-Corti and Donovan, 2002). Social support is known to be a key element of the social environment (Stahl et al., 2001). Although dozens of conceptual definitions have been offered (Wilcox and Vernberg, 1985), social support is generally conceived as the functional content of social relationships (Sallis, Grossman, Pinski, Patterson, and Nader, 1987) and refers to any behavior from the social environment that assists an individual in achieving desired goals or outcomes (Duncan, Duncan, and Stryker, 2005). While the operationalization of social support continues to be an unresolved issue for social scientists (O'Reilly and Thomas, 1989) and the source of social support is rarely distinguished (Saunders, Motl, Dowda, Dishman, and Pate, 2004), there seems to be some consensus (De Bourdeauhuij and Sallis, 2002; House, 1980; O'Reilly and Thomas, 1989; Thrasher, Campbell, and Oates, 2004; Vaux, 1988; Wilcox and Vernberg, 1985) that social support can be divided into instrumental support (e.g. offering to participate in physical activity), informational support (e.g. advising about physical activity), emotional support (e.g. comforting when starting a physical activity program) and appraisal/encouragement (encouraging to stay physically active). Additionally, sources of social support are usually divided into family and friend support (Antonucci, 1985; Duncan, Duncan and Stryker, 2005; Sallis, Grossman, Pinski, Patterson, and Nader, 1987; Treiber et al., 1991). Positive associations between social support and physical activity have consistently been found (Courneya and McAuley, 1995; Courneya, Plotnikoff, Hotz, and Birkett, 2000; De Bourdeauhuij and Sallis, 2002; Duncan, Duncan, and Stryker, 2005; O'Reilly and

Thomas, 1989; Rhodes, Jones, and Courneya, 2002; Saunders, Motl, Dowda, Dishman, and Pate, 2004; Stahl et al., 2001; Treiber et al., 1991). Nevertheless, the specific effects of different sources and types of social support on physical activity are still not clear (Duncan, Duncan, and Stryker, 2005), nor are the mechanisms through which social support might influence physical activity (Duncan, Duncan, and Stryker, 2005; Stahl et al., 2001).

One mechanism that may be of theoretical and practical relevance is derived from Social Cognitive Theory (SCT) (Bandura, 1986). SCT is the most commonly used theoretical framework for physical activity interventions (Lewis, Marcus, Pate, and Dunn, 2002) and proposes that personal and environmental factors operate as reciprocal determinants of behavior. Moreover, SCT specifies a core set of determinants and the mechanisms through which they work. The primary cognitive factor in SCT is self-efficacy, which refers to beliefs in one's capabilities to organize and execute the courses of action required to produce given levels of attainments (Bandura, 1998). Self-efficacy is generally assessed by rating one's confidence in the ability to perform a behavior under a variety of circumstances (Ajzen, 2002) and is often regarded as synonymous with perceived behavioral control used in the Theory of Planned Behavior (Ajzen, 1991; Ajzen, 1998; Armitage, 2005). Self-efficacy and perceived behavioral control have frequently been found to be positively associated with physical activity (Hagger, Chatzisarantis, and Biddle, 2002; Sallis, Hovell, and Hofstetter, 1992). Moreover, both are theorized to act as mediators between external stimuli (e.g. social support) and behavioral outcomes. Self-efficacy beliefs are the result of a complex process that relies on cognitive processing of, amongst others, social influences indicating that one possesses certain capabilities (Bandura, 1989). Thus, a high level of social support for physical activity is thought to increase an individual's level of self-efficacy for being physically active, which in turn increases the likelihood of engaging in physical activity. Evidence exists that self-efficacy and/or perceived behavioral control (partly) act as mediators in the social support - physical activity relationship (Courneya and McAuley, 1995; Duncan and McAuley, 1993; Trost et al., 2003). Nevertheless, such studies have rarely differentiated between different types of social support (Courneya and McAuley, 1995; Courneya, Plotnikoff, Hotz, and Birkett, 2000; Rhodes, Jones, and Courneya, 2002; Saunders, Motl, Dowda, Dishman, and Pate, 2004) and focused mainly on vigorous physical activity. Moderate levels of physical activity are, however, arguably more important in order to halt or revert to current obesity epidemic (Westerterp, 2001), but it is not yet clear if the relationships between social support, self-efficacy and vigorous physical activity are directly transferable to moderate levels of physical activity (Courneya and McAuley, 1994; Stahl et al., 2001).

The purpose of the present cross-sectional study was to explore the relative influences of different types (instrumental, informational, emotional, and appraisal) and sources (family and friends) of social support with moderate and vigorous physical activity. Structural equation modeling was used to model the potential direct associations of sources and types of social support, and the mediator effect of situational-specific self-efficacy concepts with vigorous physical activity (model 1) and moderate physical activity (model 2).

METHODS

Design and sample

Data for the present study were available from the 1996/1997 data collection of the Amsterdam Growth And Health Longitudinal Study (AGAHLIS). The design of this longitudinal study is described in full detail elsewhere (Kemper, 1995; 2004). In brief, the AGAHLIS started in 1977 and used a multiple longitudinal design in which repeated measurements are made in three birth cohorts (1962, 1963, and 1964). The subjects were recruited from two secondary schools in Amsterdam and Purmerend. Measurements were taken of a wide range of life-style, health and psychological characteristics. For the present analyses, 431 respondents (234 females and 197 males) were included. Age ranged from 31 years to 35 years, with a mean age of 32.37 (SD = .89).

Physical activity

A structured face-to-face interview based on a physical activity questionnaire (PAQ) (Verschuur, 1987) was held. The PAQ questioned respondents on the duration (in minutes), frequency (per week) and intensity (metabolic rate) of physical activities during the 3 months preceding the interview. The following activities were included in the interview: organized and unorganized sports activities, leisure time activities, activities at work, and walking and cycling. Activities shorter than 5 minutes and less than four times the basal metabolic rate (BMR, 4 MET) were not taken into consideration. Two levels of intensity were used in the present study: moderate physical activity (7-10 MET) and vigorous physical activity (>10 MET) (Kemper, 1985). A single score was computed by as the average weekly time (in minutes) spent in either moderate or vigorous physical activity.

Self-efficacy

Based on Sallis, Pinski, Grossman, Patterson, and Nader (1988), thirteen items were used to assess self-efficacy. Respondents were asked to indicate on five-point scales (-2 =

never; +2=very often) whether they would be physically active, even when in the following specific situations: I am tired; I am depressed; I am worried; I am angry; I am tense; I am sad; I have lots of work to do; friends are coming over; others want me to accompany them; family and/or partner demands time; no one will join me; it is bad weather; there is something interesting on television. Scores were coded in such a way that a higher score meant higher self-efficacy for being physically active.

Social support

Based on Sallis, Pinski, Grossman, Patterson, and Nader (1987), eleven items from seven sources were used to assess social support for physical activity. Respondents were asked to indicate on five-point scales (-2=never; +2=very often) the frequency with which their partner, friends, co-workers, brother(s), sister(s), father and mother had done or said what was described in each of the items (see Table 1). The different types of family support were computed by summing the relevant items from partner, brother, sister, father, and mother and dividing that score by 5. Summing the relevant items from friends and co-workers and dividing that score by 2 computed the different types of friend social support. Scores were coded in such a way that a higher score meant a higher received social support.

Analysis plan

Model fit

Analyses were performed through the construction of measurement and structural models in AMOS 4.0 (Arbuckle and Wothke, 1999). The fit of these models was evaluated using the chi-square goodness-of-fit test, which assesses the adequacy of the theorized model's covariance matrix in comparison with the observed covariance matrix. Because this test is known to be sensitive to sample size (Bollen, 1989), additional fit indices were used to assess model fit (Hu and Bentler, 1999). The root mean square error of approximation (RMSEA) was used to represent closeness of fit. Values approximating zero and .06 respectively indicate exact and close fit of the model (Hu and Bentler, 1999). The Normed-Fit Index (NFI) and Comparative Fit-Index (CFI) were used to test proportionate improvement in model fit by comparing the target model with the independence model (Bentler, 1990). Minimum value for acceptable fit is .90, while values approximating .95 are indicative of good fit (Bentler, 1990). The Akaike Information Criterion (AIC) was used as an additional source for model fit. The model with the lowest AIC provides the most adequate and parsimonious fit (Kline, 2005). Since there were

some missing responses (< 1%), full-information maximum-likelihood (FIML) was used to estimate parameters. FIML is an optimal method for the treatment of missing responses in SEM (Arbuckle and Wothke, 1999). Because maximum-likelihood estimation tends to overestimate test statistics for non-normal data (Curran, West, and Finch, 1996), the normality of the items and variables used were investigated in terms of its skewness and kurtosis. Non-normality was indicated by skewness > 2 and kurtosis > 7 (West, Finch, and Curran, 1995).

Preliminary analyses

The initial analyses focused on testing the separate factorial validity for the self-efficacy and social support concepts, in line with the approach recommended by Joreskog (1993). Regarding self-efficacy, exploratory factor analysis was conducted in SPSS to derive specific situational self-efficacy scales. This analysis indicated three situations (1 = emotional situations; 2 = social situations; 3 = opportunities). Since scales derived from exploratory procedures should be confirmed using more rigorous procedures (Joreskog and Sorbom, 1993), confirmatory factor analysis in AMOS 4.0 (Arbuckle and Wothke, 1999) was used to compare model fit for the three-factor scale with the model fit for the one-factor scale. For the latent variables, the loading of the first indicator was set to 1 in order to create its metric. As indicated by the lower AIC value, the one-factor model provided a worse fit to the data, $\chi^2(62, N = 431) = 764.21, p < .001, NFI = .81, CFI = .82, RMSEA = .16, AIC = 842.21$, than the three-factor model, $\chi^2(62, N = 431) = 350.17, p < .001, NFI = .91, CFI = .93, RMSEA = .10, AIC = 434.17$. However, the three-factor model contained three items (tired; lot of work to do; sad) that were not uni-dimensional. These items were removed and the subsequent re-estimated three-factor model provided good fit to the data $\chi^2(31, N = 431) = 78.55, p < .001, NFI = .97, CFI = .98, RMSEA = .06, AIC = 146.55$.

With regard to social support, confirmatory factor analysis was conducted in AMOS 4.0 (Arbuckle and Wothke, 1999) to test the overall fit of the proposed types and sources of social support. The items used to assess social support were categorized as encouragement, informational, emotional, or instrumental support (see Table 10). The fit of this four-factor social support model was compared with the one-factor social support model. For the latent variables, the loading of the first indicator was set to 1 in order to create its metric. Confirmatory factor analysis indicated that model fit for the one-factor model, $\chi^2(201, N = 431) = 2913.06, p < .001, NFI = .84, CFI = .85, RMSEA = .18, AIC = 3061.06$, was worse than model fit for the four-factor model, $\chi^2(179, N = 431) = 605.53, p$

$< .001$, NFI = .97, CFI = .98, RMSEA = .07, AIC = 797.52. Consequently, three factors for self-efficacy and four factors for social support were used in the measurement and structural model.

Model specification

Based on the recommended two-step approach by Anderson and Gerbing (1988), the measurement model and structural model were constructed separately. In the first step, confirmatory factor analysis was used to test whether the proposed factors were adequately defined. This overall measurement model consisted of eleven latent variables (i.e. three self-efficacy variables, four family social support variables and four friend social support variables) and two observed variables (i.e. moderate and vigorous physical activity), which were all allowed to correlate. For the latent variables, the loading of the first indicator was set to 1 in order to create its metric. The adequately defined factors from the final measurement model were used for the path analyses in the structural model.

Mediator analyses

In order to test if self-efficacy would act as a mediator in the social support-physical activity relationship, mediator analyses were conducted based on the recommendations by Holmbeck (1997). First, model fit was assessed for the direct effect of social support on physical activity (A-C). Non-significant effects were deleted and the model re-estimated. Next, self-efficacy variables were allowed to mediate these direct effects on physical activity (A-B-C). Again, non-significant effects were deleted and the model re-estimated. The final step was to assess to fit of the A-B-C model under two conditions: (1) the path A-C is constrained to zero, and (2) the path A-C is freed for estimation. In case of a mediator effect, the addition of the freely estimated A-C path should not result in a significant improvement in model fit. Since this involved testing in nested models, the likelihood ratio (chi-square difference test) (Bollen, 1989) was used to assess improvement in fit. Finally, an iterative process was followed with backward deletion of the non-significant path with the highest p-value and the model re-estimated, leaving a final model that contained only significant paths.

RESULTS

Descriptive statistics

Mean moderate physical activity was 92.15 (SD = 119.39) minutes per week and mean vigorous physical activity was 35.92 (SD = 59.95) minutes per week. Common moderate

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activities were work-related activities ($M = 12.37$, $SD = 46.56$) and leisure time activities ($M = 29.65$, $SD = 60.36$). The most common vigorous activity was sports-related activities ($M = 34.50$, $SD = 57.65$). Overall, respondents most frequently received emotional support from family and friends (Table 10). Assumption for normality was met for all items and variables (range skewness: -1.67 to 1.31; range kurtosis: -1.11 to 4.13), except for moderate physical activity (skewness = 3.59, kurtosis = 18.57) and vigorous physical activity (skewness = 4.04, kurtosis = 28.21). After log transformation, values for physical activity scores were within acceptable range (Moderate: skewness = -.29, kurtosis = .66; Vigorous: skewness = .09, kurtosis = -1.62).

Measurement model

The initial measurement model did not provide adequate fit to the data, $\chi^2(451, N = 431) = 2275.31$, $p < .001$, $NFI = .90$, $CFI = .92$, $RMSEA = .10$, $AIC = 2631.31$. To improve the fit of the model, eight additional covariances between social support residuals were added. These covariances were allowed between similar friend and family social support items (i.e. correlated residuals between 'family made positive comments' and 'friends made positive comments'). Correlated residuals were allowed between the following items: gave me information/advice; changed their schedule; gave me encouragement; gave me rewards; made positive comments; got angry at me; criticized me or made fun of me; complained about the time. With the addition of these correlated residuals, model fit improved significantly, $\Delta \chi^2(8, N = 431) = 1273.35$, $p < .001$, and provided good fit to the data $\chi^2(443, N = 431) = 1001.96$, $p < .001$, $NFI = .96$, $CFI = .98$, $RMSEA = .05$, $AIC = 1373.96$. Thus, the items used to construct the observed scores for the structural models were adequately defined. Mean scores, standard deviations, factor loadings and interfactor correlations for the final measurement model are shown in Table 1. However, because the ratio of respondents to estimated parameters was less than 10:1 (Bollen, 1989), the structural model was constructed using observed variables instead of latent variables. Internal consistency analyses revealed acceptable psychometric properties for social support (range .61 - .80) and self-efficacy variables (range .70 - .90). Mean scores were computed using SPSS (see Table 10).

Structural model vigorous physical activity

The initial structural model, in which the direct effect of social support on vigorous physical activity was assessed, provided good fit to the data, $\chi^2(2, N = 431) = .15$, $p = .93$, $NFI = 1.00$, $CFI = 1.00$, $RMSEA = .00$, $AIC = 36.15$, with family instrumental ($\beta_1 = -.18$,

Table 10. Mean scores, standard deviations, factor loadings and interfactor correlations from the overall measurement model (continued on page 11)

Variable	Loading	Mean (SD)	1	2	3	4	5	6	7	8	9	10	11	12	13
1 Vigorous PA		35.92 (.59.95)	1												
2 Moderate PA		92.15 (109.39)	.01	1											
3 Family Informational		-72 (.62) ^a	.33***	.15**	1										
Discussed PA with me	.91***	-45 (.68)													
Gave me information on PA	.81***	-1.00 (.66)													
4 Family Emotional		1.48 (.55) ^a	.07	.14**	-.14**	1									
Got angry at me	.95***	1.44 (.60)													
Criticized me or made fun of me	.88***	1.53 (.57)													
Complained about the time	.88***	1.45 (.59)													
5 Family Instrumental		-1.05 (.58) ^a	.17**	.05	.78***	-.39***	1								
Offered to be active with me	.89***	-1.00 (.63)													
Changed their schedule	.78***	-.49 (.57)													
Planned for PA on outings	.81***	1.13 (.65)													
6 Family Encouragement		-.82 (.63) ^a	.20***	.06	.78***	-.40***	.81***	1							
Gave me encouragement	.82***	-.86 (.69)													
Gave me rewards	.79***	-.85 (.75)													
Made positive comments	.69***	-.75 (.78)													
7 Friend Informational		-.43 (.74) ^a	.35***	.15**	.62***	.00	.38***	.49***	1						
Discussed PA with me	.86***	-.04 (.78)													
Gave me information on PA	.74***	-.82 (.86)													
8 Friend Emotional		1.67 (.58) ^a	.16**	.08	.00	.75***	-.10	.22**	.05	1					
Got angry at me	.93***	1.65 (.65)													
Criticized me or made fun	.85***	1.69 (.62)													
Complained about the time	.86***	1.68 (.62)													

Table 10. Mean scores, standard deviations, factor loadings and interfactor correlations from the overall measurement model (continued from page 100)

Variable	Loading	Mean (SD)	1	2	3	4	5	6	7	8	9	10	11	12	13
9 Friend Instrumental		-.73 (.74) ^a	.29***	.17**	.49***	-.06	.50***	.58***	.79***	-.03	1				
Offered to be active with me	.88***	-.67 (.83)													
Changed their schedule	.83***	-.66 (.89)													
Planned for PA on outings	.72***	-.86 (.84)													
10 Friend Encouragement		-.82 (.74) ^a	.22***	.09	.53***	-.22***	.49***	.67***	.72***	-.25***	.84***	1			
Gave me encouragement	.80***	-.88 (.87)													
Gave me rewards	.77***	-.85 (.90)													
Made positive comments	.53***	-.72 (.93)													
11 Emotional self-efficacy		.69 (.80) ^a	.25***	.13**	.22***	.14**	.04	.08	.30***	.13*	.16**	.10	1		
depressed	.72***	.49 (.98)													
worried	.90***	.71 (.89)													
angry	.86***	.80 (.89)													
tense	.89***	.77 (.86)													
12 Social self-efficacy		-.31 (.76) ^a	.24***	.04	.20**	.03	.05	.02	.26***	-.02	.08	.05	.41***	1	
friends coming over	.70***	-.49 (.99)													
others want company	.69***	-.28 (.89)													
family/partner demands time	.61***	-.16 (.98)													
13 Opportunities		.29 (.92) ^a	.25***	.02	.18**	.16**	.04	.05	.25***	.09	.13*	.09	.53***	.50***	1
no one will join me	.65***	.23 (1.11)													
bad weather	.82***	.25 (1.10)													
something on television	.67***	.39 (1.17)													

^a = mean scores and standard deviations for observed variables
*** p < .001; ** p < .01; * p < .05

$p = .01$, family informational ($\beta = .34$, $p < .001$), friend instrumental ($\beta = .20$, $p < .001$) and friend emotional support ($\beta = .12$, $p = .003$) significantly associated with vigorous physical activity. In the second step, self-efficacy variables were allowed to mediate these effects. Except for the RMSEA, this model provided good fit to the data (see Table 11A). These fit indices served as the baseline measure against which model fit with the A-C path constrained was compared with the A-C path freed. Table 11A shows the results of the likelihood ratio tests for vigorous physical activity. Results from the $\Delta \chi^2$ -tests showed that freeing the A-C path resulted in a significantly improved model fit for family informational and instrumental support, and friend emotional and instrumental support. Backward elimination of non-significant paths resulted in the final model, which provided good fit to the data, $\chi^2(5, N = 431) = 2.72$, $p = .74$, NFI = 1.00, CFI = 1.00, RMSEA = .00, AIC = 62.72. This structural model is shown in Figure 9.

Table 11. Results from the likelihood-ratio test and model fit for nested models regarding vigorous physical activity (11A) and moderate physical activity (11B)

Table 11A: Vigorous physical activity

	$\Delta\chi^2$	df	p	χ^2	df	p	NFI	CFI	RMS	AIC
Baseline model				55.52	9	<.001	.98	.99	.11	107.52
Variable										
<i>Family informational</i>	30.78	1	<.001	24.74	8	.002	.99	1.00	.07	78.74
<i>Family instrumental</i>	8.74	1	.03	46.78	8	<.001	.99	.99	.11	100.78
<i>Friend emotional</i>	6.72	1	.01	48.80	8	<.001	.99	.99	.11	102.80
<i>Friend instrumental</i>	27.29	1	<.001	28.23	8	<.001	.99	.99	.08	82.23

Table 11B: Moderate physical activity

	$\Delta\chi^2$	df	p	χ^2	df	p	NFI	CFI	RMS	AIC
Baseline model				21.04	3	<.001	.99	.99	.12	43.04
Variable										
<i>Family informational</i>	6.55	1	.01	14.49	2	<.001	.99	1.00	.12	38.49
<i>Family instrumental</i>	13.04	1	<.001	8.00	.2	.002	.99	1.00	.08	32.00

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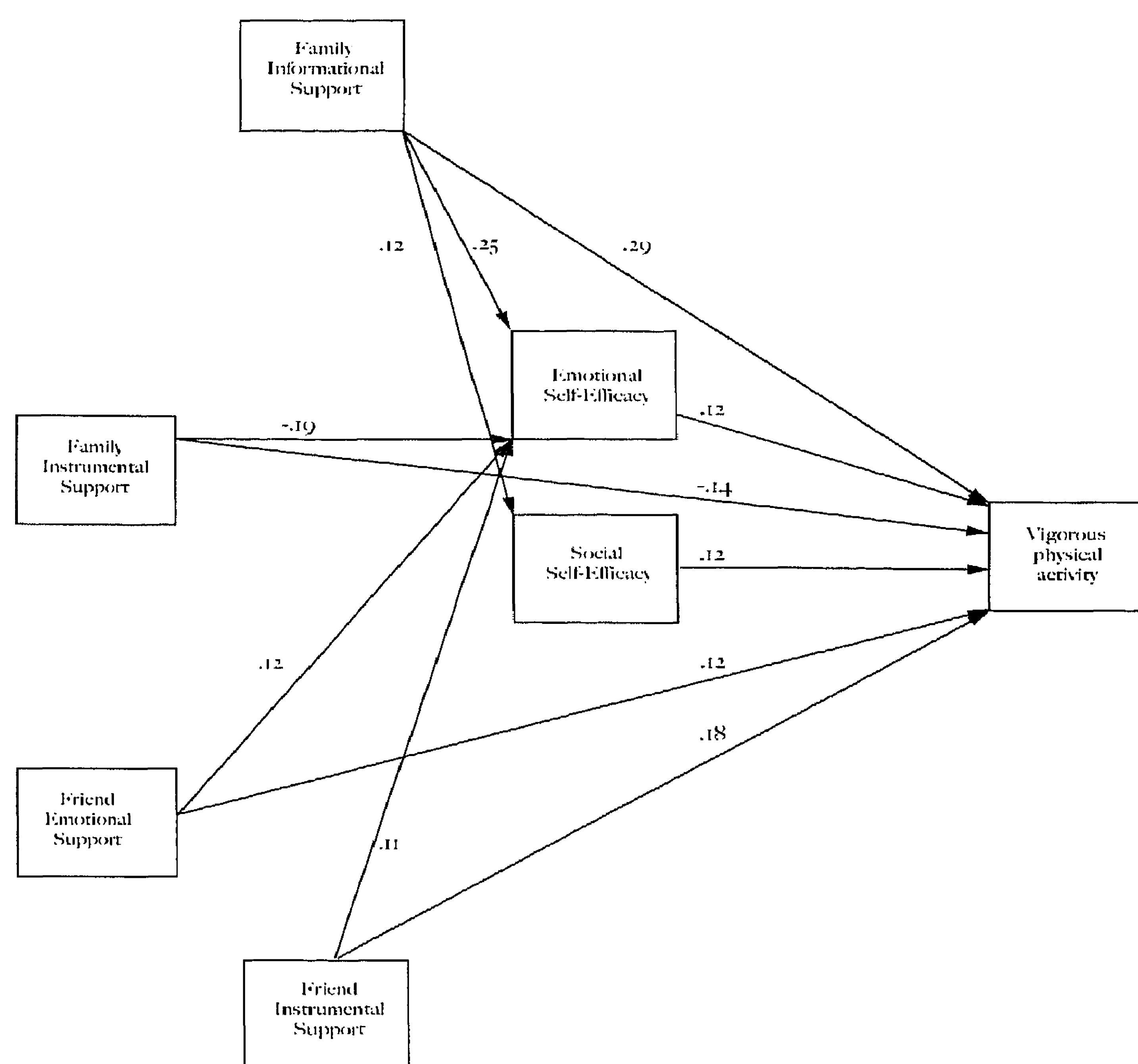


Figure 9: Standardized regression coefficients for final structural model for vigorous physical activity. Model fit: $\chi^2(5, N = 431) = 2.72, p = .74$, Normed Fit Index = 1.00, Comparative Fit Index = 1.00, Root Mean Square Error of Approximation = .00, Akaike Information Criterion = 62.72

Vigorous physical activity was significantly associated with family informational support ($\beta = .29, p < .001$), friend instrumental support ($\beta = .18, p < .001$), family instrumental support ($\beta = -.14, p = .04$), friend emotional support ($\beta = .12, p = .007$), emotional situational self-efficacy ($\beta = .12, p = .01$) and social situational self-efficacy ($\beta = .12, p = .01$). The final model explained 19 percent of the variance in vigorous physical activity, indicating a medium effect size (Cohen, 1988).

Structural model moderate physical activity

The initial structural model, in which the direct effect of social support on moderate physical activity was assessed, provided good fit to the data, $\chi^2(1, N = 431) = .36, p = .55$, NFI = 1.00, CFI = 1.00, RMSEA = .00, AIC = 16.36, with family emotional support ($\beta = .15, p = .002$) and friend instrumental support ($\beta = .19, p < .001$) significantly associated with moderate physical activity. In the second step, self-efficacy variables were allowed to mediate these effects. Except for the RMSEA, this baseline model provided good fit (Table 11B). These fit indices served as the baseline measure against which model fit with the A-C path constrained and the A-C path freed was evaluated. Table 11B shows the results of the likelihood ratio tests for moderate physical activity. Results from the $\Delta\chi^2$ -tests showed that freeing the A-C path resulted in a significantly improved model fit for family emotional support and friend instrumental support. Backward elimination of non-significant paths resulted in the final model, which provided good fit to the data, $\chi^2(3, N = 431) = 12.24, p = .07$, NFI = 1.00, CFI = 1.00, RMSEA = .08, AIC = 34.24. This structural model is shown in Figure 10 and explained six percent of the variance in moderate physical activity, indicating a small effect size (Cohen, 1988). Moderate physical activity was significantly associated with friend instrumental support ($\beta = .19, p < .001$) and family emotional support ($\beta = .15, p = .002$). Family emotional support was significantly associated with emotional situational self-efficacy.

DISCUSSION

To our knowledge, this is the first study to test a conceptual model that investigated the relative influences of various types and sources of perceived social support with adult moderate and vigorous physical activity, and the potential mediating role of different self-efficacy concepts. In general, our results support previous findings that have shown social support to be positively associated with adult physical activity. Notable different associations for various sources and types of social support were found for different intensity levels of physical activity. These differences seem to reflect earlier theorizing (Cutrona and Russell, 1990) that certain types of social support may be more relevant than others in promoting preventive behaviors, such as physical activity. Thrasher, Campbell, and Oates (2004) found emotional and instrumental support to be of particular relevance with regard to physical activity. Those findings were replicated in the present study, with friend instrumental support associated with both moderate and vigorous physical activity. However, differentiating between sources of emotional support showed that family emotional support was associated with moderate physical activity, but not

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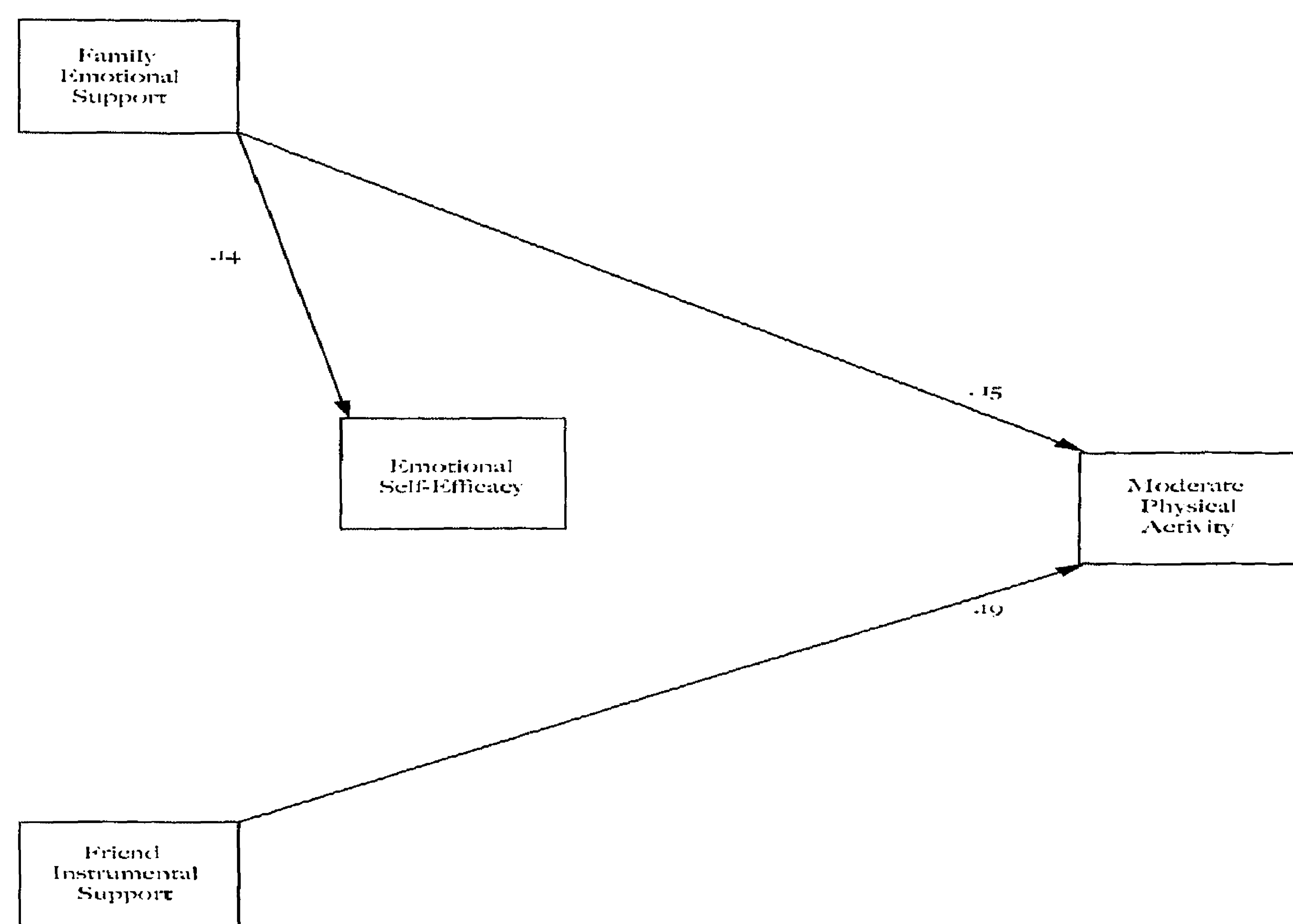


Figure 10: Standardized regression coefficients for final structural model for moderate physical activity. Model fit $\chi^2(3, N = 431) = 12.24, p = .07$. Normed Fit Index = 1.00, Comparative Fit Index = 1.00, Root Mean Square Error of Approximation = .08, Akaike Information Criterion = 34.24

with vigorous physical activity. In contrast, friend emotional support was associated with vigorous physical activity, but not with moderate physical activity. Thus, different sources and types of social support appear relevant for participation in moderate and vigorous physical activity. Beyond differentiating sources and types of social support, the present study examined whether three situational-specific self-efficacy concepts, similar to those found relevant for smoking behavior (Lawrance, 1988), would act as cognitive mediators in the social support-physical activity relationship. Self-efficacy partly mediated the direct associations of social support with vigorous physical activity, but not with moderate physical activity. Bandura (1989) has argued that execution of less demanding behaviors require little cognitive control and in those low-demanding situations, lower-level control systems are more likely to regulate behaviors. Moderate physical activity arguably requires less cognitive planning, motivation and dedication of the individual than vigorous physical activity. Participation in moderate physical activity may thus rely more strongly on instrumental and emotional supportive behaviors from others rather than on

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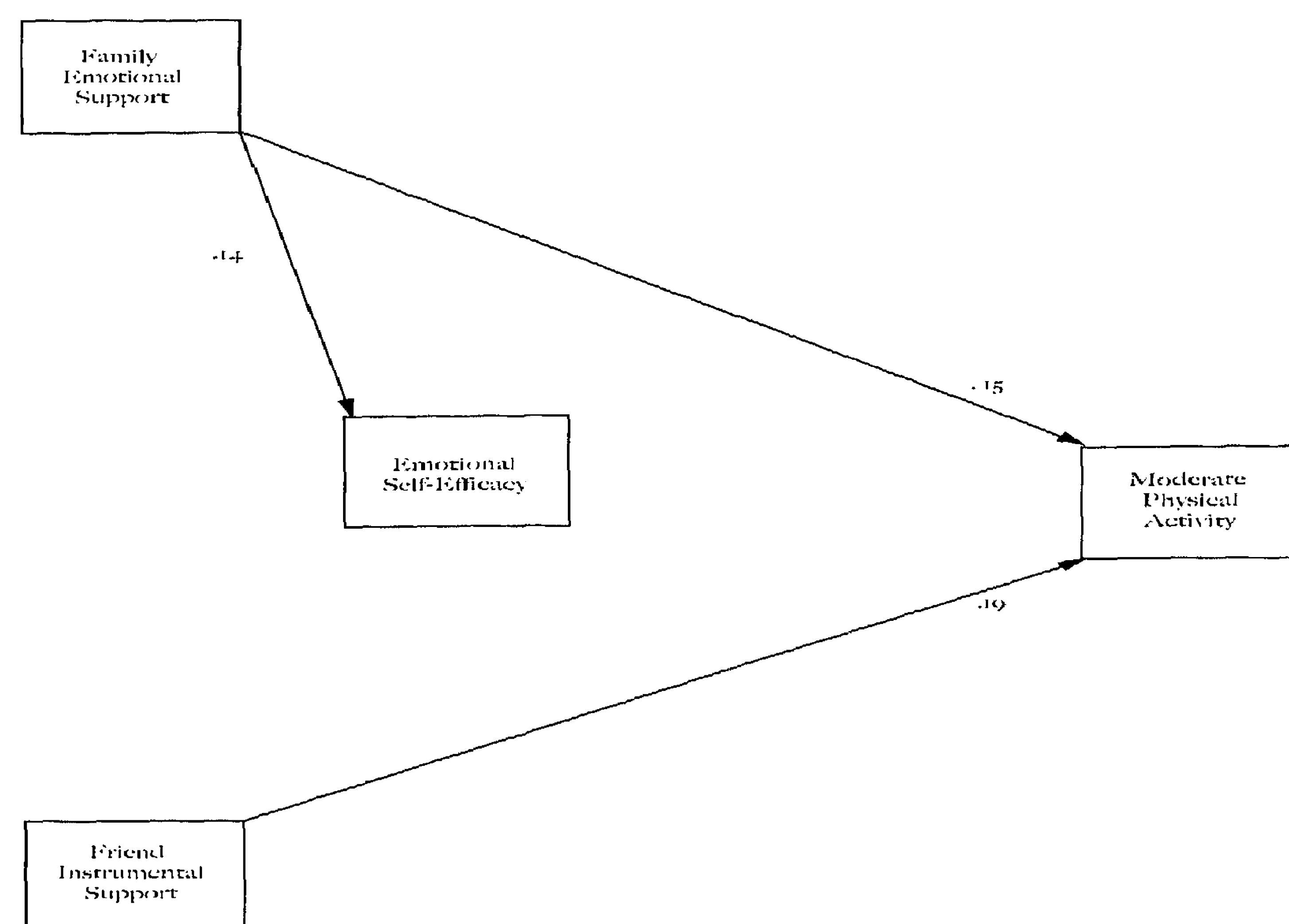


Figure 10: Standardized regression coefficients for final structural model for moderate physical activity. Model fit $\chi^2(3, N = 430) = 12.24, p = .07$, Normed Fit Index = 1.00, Comparative Fit Index = 1.00, Root Mean Square Error of Approximation = .08, Akaike Information Criterion = 34.24

with vigorous physical activity. In contrast, friend emotional support was associated with vigorous physical activity, but not with moderate physical activity. Thus, different sources and types of social support appear relevant for participation in moderate and vigorous physical activity. Beyond differentiating sources and types of social support, the present study examined whether three situational-specific self-efficacy concepts, similar to those found relevant for smoking behavior (Lawrance, 1988), would act as cognitive mediators in the social support-physical activity relationship. Self-efficacy partly mediated the direct associations of social support with vigorous physical activity, but not with moderate physical activity. Bandura (1989) has argued that execution of less demanding behaviors require little cognitive control and in those low-demanding situations, lower-level control systems are more likely to regulate behaviors. Moderate physical activity arguably requires less cognitive planning, motivation and dedication of the individual than vigorous physical activity. Participation in moderate physical activity may thus rely more strongly on instrumental and emotional supportive behaviors from others rather than on

one's own cognitive efforts. From a dual-process perspective (Moskowitz, Skurnik, and Galinski, 1999), some behaviors can indeed be the result of full cognitive processing, while others can be the result of direct automatic responses to environmental cues (Bargh and Chartrand, 1999).

Social support seems even more relevant for vigorous than for moderate physical activity. This counters earlier comments that have suggested social support to be more important for less volitional behaviors (Courneya, Plotnikoff, Hotz, and Birkett, 2000; Rhodes, Jones, and Courneya, 2002). The result of the present study underlines the need for plausible processes regarding the associations between social support and vigorous physical activity. Theoretically, social support acts in two ways (Cohen, 1988; Cohen and Wills, 1985), which both imply that support is linked to health through behavioral processes. First, social support influences outcomes directly in the so-called main-effect model. In sports-related vigorous activities, social support may exert influence by providing advice about performance (informational support) or by increasing positive effect through emotional support (Cohen, 1988). Second, according to the so-called buffering model, social support moderates the effects of stress on outcomes. Vigorous physical activity is often denoted as strenuous and requiring effort to perform (Courneya, Plotnikoff, Hotz, and Birkett, 2000; Petosa, Suminski, and Hertz, 2003; Rhodes, Jones, and Courneya, 2002) and social support may be viewed as stress-buffering through a form of facilitating these efforts (Wilcox and Vernberg, 1985). For instance, instrumental support may alleviate stress through a direct transfer of resources (Rees and Hardy, 2004) or by providing task assistance (offering to be physically active together). Although data on potential stressors were unavailable in the present study, studies have indeed found evidence for this stress-buffering effect on sports-related activities (Cohen and Wills, 1985; Rees and Hardy, 2004). Thus, social support may influence physical activity through several mechanisms, which may depend on the intensity level of physical activity.

The lack of a mediator effect of self-efficacy may also suggest the operation of additional social-cognitive mediators (Baron and Kenny, 1986), most importantly those postulated in the Theory of Planned Behavior (TPB) (Ajzen, 1991). According to the TPB, intention is the most immediate determinant of behavior. Intention is, in turn, influenced by attitude (i.e. one's evaluation of performing the behavior), subjective norm (i.e. perceived social pressure to perform the behavior) and perceived behavioral control. According to the TPB, social support is viewed as an external or so-called distal variable in the TPB and is theorized to influence behavior only through its effect on perceived behavioral control or intention. Few studies have assessed TPB-variables,

Sources and types of social support, self-efficacy and physical activity

social support variables and physical activity simultaneously. Although Saunders, Motl, Dowda, Dishman and Pate (2004) found no association of family support with intention to be physically active in adolescents girls, Courneya, Plotnikoff, Hotz, and Birkett (2000) and Rhodes, Jones, and Courneya (2002) did provide some evidence that social support is positively associated with intention to be physically active. Intention may thus be a potential mediator in the social support-physical activity association. For instance, informational support regarding physical activity may lead to a more positive attitude and, subsequently, a more positive intention towards physical activity.

The current study has strengths and limitations. A major limitation is the cross-sectional design. Both self-efficacy and social support processes are known to be dynamic and reciprocal, unlikely to be unraveled using cross-sectional data. Additionally, the items used to assess different types of social support were derived from a questionnaire that was not specifically designed to assess these different types of social support. Although the measurement model provided evidence for its factorial validity in the present sample, questionnaires that aim to assess different types of social support for physical activity should be developed and validated. Finally, the participants in the present study proved to have a slightly higher socio-economic status than the Dutch population when the AGAHLS was initiated. Although the sample in the present study showed greater diversity in occupational level (both low and high level) than their parents in the 1960s (Kemper, 1995), caution is warranted to generalize the present findings. A major strength of our study was assessing physical activity using a face-to-face interview instead of using questionnaires. Although no single method fully meets the requirements for reliable and valid assessment of activity (Dishman, Washburn, and Schoeller, 2001), standardized interviews are considered more valid than questionnaires (Montoye, Kemper, Saris, and Washburn, 1996). An additional strength of the present study was the use of structural equation modeling to test the factorial validity of social support and self-efficacy concepts and to simultaneously examine their relative influence on physical activity.

In sum, our results have indicated that the associations between sources and types of social support differ between moderate and vigorous physical activity. Self-efficacy concepts were unable to (fully) mediate these associations. If these results are further supported by longitudinal studies, they have important implications for interventions that aim to increase moderate and/or vigorous physical activity levels more effectively and efficiently. Interventions that target increased levels of moderate physical activity should be specifically targeted at increasing social support rather than increasing self-efficacy for being physically active. Promotion of vigorous physical activity, however, may benefit

more from a combined intervention aimed at increasing both social support and self-efficacy levels. Potential areas for future research include the investigation of additional mediators in the social support-physical activity domain, such as intention and attitude towards physical activity. Additionally, longitudinal studies are needed that model changes in social support and self-efficacy with changes in moderate and vigorous physical activity.

Part Three

Exploring potentially relevant individual-level factors

Chapter 7

Is personality related to fruit and vegetable consumption and physical activity in adolescents?

Based on: G.J. de Bruijn, S.P.J. Kremers, W. van Mechelen, and J. Brug (2005). Is personality related to fruit and vegetable intake and physical activity in adolescents? *Health Education Research*, 20: 635-644

ABSTRACT

Personality is regarded as a distal determinant of health behavior and has been found to be associated with health behavior in young adults. Research investigating the association between personality and health behaviors in adolescents, however, is lacking. The present study explored the direct associations between Big Five personality dimensions with fruit and vegetable consumption, and physical activities in two Dutch adolescent samples (Sample 1: $n=504$; mean age=14.5 years ($SD=1.7$); response rate 20%. Sample 2: $n=476$; mean age=14.9 ($SD=2.0$); response rate 17%). Behavioral outcomes and personality were assessed with validated self-administered questionnaires. Bivariate correlations and multiple regression analyses were conducted and Cohen's effect sizes were used to interpret the associations found. Agreeableness was positively associated with vegetable consumption, while Openness to Experience was positively associated with fruit consumption and vegetable consumption. Extraversion was positively associated with sports-related physical activity. Standardized regression coefficients for personality dimensions ranged from .09 to .13, explaining 3 to 6 percent of variance in behavior, indicating small effect sizes. Our results suggest that personality dimensions are associated with fruit and vegetable consumptions and sports-related physical activity in adolescents. Future research should explore possible mediators between personality and health behavior in adolescents.

INTRODUCTION

Healthy behaviors, such as regular physical activity, non-smoking and a diet high in fruit and vegetables contribute to the improvement of public health (WHO, 2003). In order to promote healthy behaviors, it is necessary to study possible determinants of these behaviors. Most studies to date have focused on so-called proximal behavioral determinants, primarily cognitions such as those proposed in the Theory of Planned Behavior (TPB) (Ajzen, 1991). Recently, scientific attention has focused on more distal determinants of health behaviors, such as availability and accessibility of healthy dietary choices (Fisher and Birch, 1999; Zive et al., 2002) and physical activity opportunities (Sallis et al., 2002; Zask et al., 2001). In addition to such physical environmental influences, personality dimensions are also regarded as potentially important distal determinants of health behaviors (Flay and Petraitis, 1994; Rhodes et al., 2003).

Unlike attitudes and intentions, which are behavior-specific, personality refers to broad dispositions, which may enable us to understand why certain individuals behave in a healthier fashion than others (Millet et al., 2004), beyond those explanations given by social cognitions. For instance, in a study among undergraduate students, Rhodes and colleagues (2002; 2003) found that personality accounts for prediction of exercise behavior beyond one's intention to exercise. In a similar study among university students, Conner and Abraham (2001) found that social cognitions only partially mediated the direct effect of personality on exercise behavior. These studies suggest that social cognitions are inadequate to fully explain the relationship between personality and exercise behavior, thus providing some evidence that personality may be an important additional predictor of health behavior.

Personality research in the last decade has been largely based on the so-called Big Five dimensions (Costa and McCrae, 1985), which are typically labelled as Extraversion, Agreeableness, Conscientiousness, Emotional Stability and Openness to Experience. Extraversion includes gregariousness, assertiveness, warmth, excitement seeking, activity and positive emotions. Facets of Agreeableness include modesty, compliance, straightforwardness, trust, altruism and tender-mindedness. Achievement, striving, self-discipline, deliberation, order and dutifulness are facets of Conscientiousness, while Emotional Stability includes depression, hostility, impulsiveness, vulnerability, self-consciousness and anxiety. Openness to Experience is characterized by aesthetics, feelings, fantasy, ideas, actions and values (Costa and McCrae, 1992). These dimensions have been found irrespective of factor analytical techniques (Goldberg, 1990), method of assessment (McCrae and John, 1992), language (De Raad et al., 1998) and appear universal across cultures (Jang

et al., 1998). Studies have generally found Agreeableness and Conscientiousness to be positively correlated with a healthy diet. For instance, Booth-Kewley and Vickers (1994) found that more conscientious individuals engaged in more wellness behaviors, including eating a healthy diet, with correlations ranging from .31 to .45. In another study (Lemos-Giráldez and Fidalgo-Alisto, 1997), Conscientiousness and Agreeableness were positively associated with health behavior, most notably a diet high in fruit and fibre, and low in fat and salt. In addition, this study also showed that more conscientious and more agreeable individuals had a more positive attitude towards these healthy diets. The personality dimensions explained six to twelve percent of the variance, with standardized regression coefficients ranging from .12 to .22. Regarding PA, several studies (Courneya et al., 1999; Rhodes et al., 2002; Rhodes et al., 2003) have found Extraversion to be positively associated with exercise behavior such as walking and jogging, with standardized regression coefficients ranging from .14 to .28.

To date, however, studies focusing on an association between personality and health behaviors have been conducted in (young) adult samples, even though the Big Five personality dimensions have been identified in both late childhood (Barbarelli et al., 2003; Mervielde et al., 1995) and adolescence (Scholten et al., 1997). The present study explored the direct association between the Big Five personality dimensions and important health behaviors in a Dutch adolescent sample, viz., fruit and vegetable consumption, routine PA and sports-related PA. In line with the associations found in (young) adult populations, we hypothesized that more agreeable and more conscientious adolescent would consume more fruit and vegetables. We further hypothesized that more extraverted adolescents would be more active in both routine PA and sports-related PA.

METHODS

Subjects and procedures

In the present study, 12-to-18-year-olds were requested to complete a questionnaire as part of a large, ongoing prospective cohort-study in the city of Eindhoven, a city of approximately 200,000 inhabitants located in the southern part of the Netherlands. In this prospective study, all patients over 12 years of age (some 35,000 patients), which are covered by the 7 medical practices in Eindhoven, were invited to participate. Of these 35,000 patients, some 2,800 are in the age bracket of 12 to 18 year. In this age group, informed consent is required from both the respondent and their parents. Participant addresses were obtained through the General Practitioners. Anonymity was guaranteed and respondents were informed that GPs would not be informed about participation. Only those

adolescents of whom informed consent was received from themselves and their parents were included in the study. In case of non-response to the initially mailed questionnaire, a reminder was sent two weeks later. In November 2002 and May 2003, 12-to-18-year-olds ($n = 2536$ and $n = 2837$, respectively) were invited to complete a self-administered questionnaire at home. For both samples, questionnaires were identical. In addition to the questionnaire sent, an explanatory covering letter and reply-paid envelope were included. In November 2002, 504 (response rate 20%; 296 girls and 208 boys; mean age = 14.5 years ($SD = 1.7$)) and in May 2003, 476 (response rate 17%; 263 girls and 213 boys; mean age = 14.9 years ($SD = 2.0$)) adolescents completed the questionnaire. Since both samples did not differ on demographics, we combined both samples to allow greater statistical degrees of freedom and to increase the power of our analyses. Those of whom questionnaires were received on both occasions ($n = 155$) were removed from the second sample before merging the data sets, leaving a total sample of 825 (468 girls and 357 boys; mean age = 14.8 years ($SD = 2.0$)).

Measures

Big Five personality dimensions were assessed using a shortened version of a Dutch translation of Goldberg's adjective 100 list (Gerris et al., 1998). Respondents were asked to indicate on a 7-point scale whether or not they agreed (0 = totally agree; 7 = totally disagree) with such statements as 'I am creative; I am quiet; I am helpful; I am careless'. Adolescents in the age range 12 to 18 years have been found to give reliable reports on this shortened, 30-item questionnaire (Scholte et al., 1997).

Fruit consumption and vegetable consumption were assessed with respectively 5 items and 2 items from a validated questionnaire (Van Assema et al., 2002; Bogers et al., 2004). Regarding fruit consumption, respondents were asked to indicate on how many days per week they consumed the following fruits (1 piece = 125 grams): apples, pears, bananas, citrus fruits (oranges, grapefruits, lemons, tangerines) and other fruits. Additionally, respondents were asked to indicate the number of pieces they consumed of each of those fruits on such a day. Two pieces of tangerines were considered as 1 piece of fruit. A single score was computed for the average amount of grams of fruit per day. Regarding vegetable consumption, respondents were asked to indicate on how many days per week they consumed heated vegetables and raw vegetables. They were further asked to indicate the number of serving spoons (1 serving spoon = 50 grams) they consumed of both heated and raw vegetables on such a day. A single score was computed for the average amount of grams of vegetables per day.

PA was assessed using a validated questionnaire. The relative validity of this questionnaire was assessed by comparing it with a seven-day physical record. Spearman rank order coefficient was 0.50 between these two methods and 0.73 for the test-retest reliability. Cohen's kappa was 0.33 between these two methods and 0.58 for the test-retest reliability (Ronda et al., 2001; Koremans et al., 2000). Respondents were asked to indicate on how many days per week they were engaged in various physical activities for at least 10 minutes a time. In addition, respondents were asked to indicate for how many minutes a day they were engaged in each of these activities. A single score for average minutes per day was computed for both the amount of routine PA (walking, cycling, using stairs, gardening, and household labour) and for sports-related PA (jogging, swimming, gymnastics, tennis, martial arts, canoeing, field sports and skating).

Analyses

Spearman (gender) and Pearson correlations were computed between behavioral outcomes, gender, age and each of the Big Five dimensions. We used multiple linear regressions with Big Five dimensions as the independent variables and each of the behavioral outcomes as the dependent variable. Furthermore, if gender and/or age were significantly correlated with a behavioral outcome in the bivariate analyses, we adjusted for this demographic variable in the multiple regression analysis. The magnitude of the effect size was used as the main source of information, since it is insensitive to group sizes (Tabachnick and Fidell, 1996; Rigby, 1999). Effect size interpretations were based on Cohen's (Cohen, 1988 p.79-81) descriptive guidelines. For univariate analyses, effect sizes between .10 and .30 were defined as small. Effect sizes between .30 and .50 were defined as medium sized, while effect sizes larger than or equal to .50 were defined as large. In the multiple regression analyses, effect sizes (F) were computed by dividing the amount of explained variance (r^2) by the amount of error variance ($1-r^2$). Effect sizes were regarded as small when they were between .02 and .15, medium between .15 and .35 and large when equal to or larger than .35 (Cohen, 1988; p. 413-414). Effect sizes for multiple regression analyses are based on the total effect the independent variables have on the dependent variable and, since these independent variables are standardized values, a single best predictor can be pointed out.

RESULTS

Table 12 shows the mean consumption per day of fruit and vegetables and the average amount of routine PA and sports-related PA. Respondents consumed on average 125

(SD=96.0) grams of fruit and 97 (SD=100.0) grams of vegetables per day. Eighteen percent met the recommendation of 250 grams of fruit per day, while 13 percent met the recommendation of 200 grams of vegetables per day. Respondents spent on average 42.3 (SD=41.6) minutes per day on routine PA and 34.5 (SD=46.7) minutes per day on sports-related PA. A total of 50.3 percent met the recommendation of being physically active (routine PA and sports-related combined) for at least 60 minutes per day on every day of the week (Kemper et al., 2000).

The univariate analyses (Table 12) showed that adolescents who consumed more fruit and vegetables were more agreeable. Additionally, adolescents who consumed more fruit and vegetables were more open to experience, while adolescents who were more active in sports-related PA were more extraverted. All correlations larger than .10 were statistically significant and effect sizes of the found correlations were small.

In the regression analyses (Table 13), Agreeableness and Openness to Experience were positively and significantly associated with vegetable consumption: adolescents who consumed more vegetables were more agreeable and more open to experience. In addition, Extraversion was positively and significantly associated with sports-related PA: adolescents who spent more time in sports-related PA were more extraverted. Finally, Openness to Experience was positively and significantly associated with fruit consumption: adolescents who consumed more fruit were more open to experience. The independent variables explained six percent variance in vegetable consumption and sports-related PA, and three percent variance in fruit consumption. The effect sizes in the multivariate analyses were small, while no significant associations were found for routine PA.

DISCUSSION

In modern health psychology, the impact of chronic illness on the psychological development of individuals has received much attention, however not as much as the inverse relationship, i.e. the impact of personality on healthy behaviors (Van Heck, 1997). With the current increase in unhealthy lifestyles, a stronger focus is needed on prevention, for instance to halt the current obesity epidemic (Goran et al., 1999). In the present study, we explored the direct association between personality and important health behaviors, viz. fruit and vegetable consumption, and physical activities, in a Dutch adolescent sample. Results from both the univariate and multivariate analyses lent some support for our hypotheses. More extraverted adolescents spent more time in sports-related PA. Furthermore, in the univariate analyses, we found that Agreeableness was positively correlated with fruit consumption and vegetable consumption. In the multivariate analyses, Agree-

Table 12. Bivariate correlations between Big Five dimensions, fruit consumption, vegetable consumption, routine physical activity, sports-related physical activity, gender, and age

		Cronbach	Mean (SD)	1	2	3	4	5	6	7	8	9	10	11
1	Extraversion	.83	29.10 (7.0)	1	.24***	-.10**	-.41***	.20***	.05	.09	.04	.11**	.04	.007
2	Agreeableness	.81	33.11 (4.7)		1	.22***	.01	-.42***	-.13***	.10***	.06	.05	.08*	.03
3	Conscientiousness	.84	26.06 (7.0)			1	-.08	.12	.00	.08	.00	.07	.09	.43***
4	Emotional Stability	.80	25.58 (6.7)				1	-.02	.02	.04	.00	.06	-.18***	-.14***
5	Openness to Experience	.72	28.59 (5.8)					1	.14***	.20***	.07	.02	.03	.02
6	Fruit		125 (96.0)						1	.51***	.25***	.14***	.09*	.03
7	Vegetable		97 (100.0)							1	.23***	.14***	.04	.08
8	Routine PA		42.3 (41.6)								1	.29***	.05	.04
9	Sports PA		34.5 (46.7)									1	-.08*	-.10***
10	Gender												1	.08
11	Age													1

* p < .05; ** p < .01; *** p < .001

Table 13. Standardized regression coefficients from multiple regression analyses with fruit consumption, vegetable consumption, routine physical activity, sports-related physical activity as dependent variables and Extraversion, Agreeableness, Conscientiousness, Emotional Stability, and Openness to Experience as independent variables

	Extraversion	Agreeableness	Conscientiousness	Emotional Stability	Openness to Experience	Gender ^d	Age ^d	R ²	F ^e	F (df)
Fruit	.004	.075	.061	.017	.101*	.058		.03	.03	4.43 (6)
Vegetable	.026	.122**	.042	.032	.130**		.084*	.06	.06	8.33 (6)
Routine PA	.024	.035	-.011	-.018	.042			.00	.00	.083 (5)
Sports PA	.085*	.070	-.054	-.043	-.031	.135***	-.186***	.06	.06	8.07 (7)

ableness remained positively and significantly associated with vegetable consumption. Contrary to our hypotheses, Openness to Experience was also positively associated with both fruit consumption and vegetable consumption. The standardized regression coefficients for the Big Five dimensions ranged from .09 to .13 and explained 3 to 6 percent variance in behavior, although for sports-related PA this is mainly due to the effects of gender and age in the regression equation. Studies focussing on personality associations with other health behaviors, such as risky sexual behavior (Miller et al., 2004) and oral self-care (Kressin et al., 1999) have reported similar findings in terms of standardized regression coefficients and explained variance.

The low amount of explained variance and the values of the standardized regression coefficients seem somewhat disconcerting and call the practical relevance of personality assessment in health behavior into question, especially when comparing our results with studies that focus on more proximal determinants of health behavior, for example studies based on the TPB. The TPB explains some 30 percent variance in self-reported behavior, with standardized regression coefficients usually ranging from .20 to .50 (Armitage and Conner, 2001; Godin and Kok, 1996). Concepts used in TPB, such as attitude and intention, are behavior-specific and dynamic in nature, whereas personality dimensions are stable over time and situations (Roberts and DelVecchio, 2000; West and Graziano, 1989). It has been argued (Conner et al., 2000; Rhodes et al., 2004) that social cognitive variables lack temporal stability in measurement, which has been acknowledged by Ajzen (2002) to be a principle limitation in the TPB. Indeed, a study in the exercise domain (Courneya and McAuley, 1993) found that intention was unstable even over a 2-day duration, suggesting a more stable construct, such as personality, is needed to explain and predict health behaviors over time (Rhodes et al., 2004). In addition, the act of eating is known to be complex and to involve many 'decisions' at environmental, psychological, psychosocial and behavioral levels (Baranowski et al., 2003). For instance, when one is consuming vegetables (behavioral), vegetables need to be available (environmental), one should have a positive attitude and intention (psychosocial) towards vegetable consumption, and perhaps one should be psychologically inclined towards vegetable consumption.

Our results showed that Agreeableness was positively associated with vegetable consumption. This may seem plausible, since vegetable consumption is likely to take place at the dinner table where parental influence may be strong. For instance, parents may actively encourage vegetable consumption by setting family eating rules (Nicklas et al., 2001). Since Agreeableness consists of such traits as compliance, more agreeable adolescents may be more prone to obey these rules. Openness to experience revealed the

strongest effects on fruit and vegetable consumption in terms of standardized regression coefficients. Although contrary to our hypotheses, a recent study (Goldberg and Stryker, 2002) found Openness to Experience to be positively associated with fibre consumption. These authors stated that this association should be understood in the present context: our current environment is considered to be obesogenic (WHO, 2003), making the consumption of an unhealthy diet easy and accessible. Individuals who are more open to experience might be more likely to eat foods that are not readily available. Furthermore, studies in the field of food neophobia have found positive associations between experience seeking, which is a subtrait of Openness to Experience, and the consumption of novel foods (Otis, 1984; Pliner and Hobden, 1992). Since humans are born with an innate dislike of sour tastes (Desor et al., 1975; Rossenstein and Oster, 1988), children and adolescents that are more open to experience are perhaps more likely to consume sour foods. Indeed, a recent study (Liem, 2004) showed that boys who had a preference for sour taste consumed more fruits. Our finding that Extraversion was associated with sports-related PA is in line with previous studies among adults (Rhodes et al., 2002; 2003).

The theoretical models most commonly applied to explain health behaviors primarily focus on the more proximal social cognitive determinants, such as attitude, subjective norm and perceived behavioral control (Ajzen, 1991). These social cognitions may be better modifiable through interventions (Glanz, 2002), but such interventions are not always successful in inducing behavior change (Baranowski et al., 2003; Hardeman et al., 2002). This may, in part, be due to the fluctuations in the levels of these social cognitions (Rhodes et al., 2004). It has been suggested that *"interventions will likely benefit from consideration of one's personality along with social cognitions until we better understand the mechanisms responsible for these fluctuations"* (Rhodes et al., 2004). Although these authors have focussed on the exercise domain, our results provide some suggestion that a similar consideration could apply in the diet domain, more specifically fruit and vegetable consumption in adolescents.

The TPB proposes that the relation between personality and behavior is mediated by social cognitive factors and intention. Recent studies, however, have indicated that social cognitions do not always fully mediate personality influences (Conner and Abraham, 2001; Courneya et al., 1999) and cultural and physical environment influences (De Bruijn et al., 2005) on physical activity. Conceptually, a mediating variable explains how or why an independent variable affects the outcome variable. This intermediary connection makes a previous significant association between the independent variable and outcome variable less strong and less significant (partial mediation) or non-existent (total

mediation) (Baron and Kenny, 1986; Kraemer et al., 2001). The direct association found between personality and fruit and vegetable consumption provides some evidence for the first prerequisite for mediation and warrants further research to establish if social cognitions mediate personality influences on other adolescent health behaviors, including diet.

Some comments should be made regarding the limitations of our study. Of the approached adolescents, 80% of the first sample and 83% of the second sample did not participate in the study. Although no formal non-response analysis was conducted, girls (both samples) and older adolescents (first sample) were more likely to participate. The now obliged informed consent procedure, involving adolescents as well as their parents, may make low response rates more probable. A more stringent concern is that non-response might be personality related. The dimensions of Agreeableness and Conscientiousness contain traits related to compliance and dutifulness respectively, which may make adolescents high on either or both of these dimensions more likely to participate. Prevalence rates of adolescents high in Agreeableness and Conscientiousness may thus have been overestimated in our sample, but it is unlikely that the validity of the found relationships between personality and health behavior is affected by the potentially selective response. Nevertheless, additional research in different adolescent samples is needed to support our findings. Furthermore, although the Big Five dimensions have achieved considerable popularity in the field of personality psychology, some concerns regarding the Big Five dimensions have been expressed (Block, 1995a; Block, 1995b). For instance, a recent study (Scholten and De Bruyn, 2004) suggested that personality in early adolescents might also be adequately explained in terms of three dimensions, while Shiner (1998) proposed a taxonomy based on four dimensions. Although the Big Five dimensions have been claimed not to be fully developed (Goldberg and Saucier, 1995), they provide practical utility and a common language (Barbarelli et al., 2003) for research in the personality domain.

Chapter 8

Clustering of energy balance-related behaviors and their intrapersonal determinants

Based on: S.P.J. Kremers, G.J. de Bruijn, H. Schaalma, J. Brug (2004). Clustering of energy balance-related behaviors and their intrapersonal determinants. *Psychology and Health*, 19: 595-606

ABSTRACT

The consistent increase in the prevalence of obesity that currently occurs in industrialised countries can be explained by the existence of multiple behavioral actions that exert continuous pressure toward a positive energy balance. The present study examined the clustering of intrapersonal determinants of five energy balance-related behaviors (i.e., consumption of energy-dense snacks, the use of high-fat sandwich fillings, fruit consumption, active transport and physical activity during leisure time). The research population consisted of a large sample of Dutch adolescents ($n = 3859$; mean age 14.8; 55.2% girls). Attitude, subjective norm, perceived behavioral control and intention measures related to the various behaviors clustered more strongly than the behaviors themselves, with correlations ranging from 0.09 to 0.55. The consequences of adopting an energy balance approach are discussed.

INTRODUCTION

The prevalence of obesity (Body Mass Index >30) is increasing rapidly (Flegal et al., 1998). Obesity represents a major burden of disease by being linked to cardiovascular diseases such as myocardial infarction and stroke, type II diabetes, musculoskeletal disorders, work disability and impaired quality of life (Bjorntorp, 1997; Felson et al., 1997). Further, it affects life expectancy (Peeters et al., 2003) and, as the relation with morbidity is larger than with mortality (Visseher and Seidell, 2001), obesity is related to an increased number of unhealthy life-years (Visseher et al., in press). Experts agree that efforts are urgently needed to combat the obesity epidemic (e.g., Hill et al., 2000). Since treatment of obesity has proved to be problematic (NHS, 1997), efforts are needed to prevent weight gain (Russell et al., 1995).

Weight gain results from a positive energy balance (i.e. energy intake exceeds energy output). The consistent increase in body weight that is currently occurring in industrialised countries can be explained by the existence of multiple behavioral actions that exert continuous pressure towards a positive energy balance, including consumption of high fat foods, diets low in fibre and lack of activity in daily life (Hill et al., 2000; WHO/FAO, 2002). As Hill and colleagues (2000) have pointed out, no single factor can be identified as a universal causal factor in weight gain. It is the interaction of multiple factors that determines whether or not a positive energy balance and increase in body fatness are experienced. For example, behaviors that induce a positive energy balance may co-occur. Although some studies failed to show a relationship between diet and physical activity (Kronenfeld et al., 1988; Voorrips et al., 1991; Coulson et al., 1997; Wilcox et al., 2000), various other studies have suggested that dietary behaviors and physical activity behaviors are associated. Studies have shown correlations between physical activity and a prudent diet (Raitakari et al., 1995), dietary fat (Simoes et al., 1995), fibre and sucrose intake (Haraldsdottir and Andersen, 1994) and fruit and vegetable consumption (Johnson et al., 1998; Schuit et al., 2002), with active individuals having healthier diets. Recently, evidence was found for the co-occurrence of compliance with diet and exercise recommendations (Berrigan et al., 2003). Epidemiologists label the co-occurrence of behaviors as 'clustering' if a combination of behaviors is more prevalent than can be expected on the basis of the prevalence of the separate behaviors (Schuit et al., 2002). The rationale behind studying the clustering of health behaviors lies in the fact that it can identify high-risk groups and thus provide a first step toward effective primary prevention strategies (Schuit et al., 2002).

Because of the co-occurrence of behaviors such as those related to energy bal-

ance, it is to be expected that the underlying motivational constructs for these behaviors will also cluster. In addition, a strong body of research, using a within- and between-subjects approach, has shown health-related behaviors to be subject to intrapersonal tendencies regarding motivational mechanisms (Finlay et al., 1999; Sheeran et al., 1999; Finlay et al., 2002; Trafimow et al., 2002). Insight into clustering of intra-personal determinants of diet and physical activity may reveal the importance of studying and intervening in these behaviors in an energy balance approach, i.e., focusing on energy intake as well as output, instead of focusing on dietary change or physical activity change alone. On the other hand, clustering of behavioral determinants may also imply that, if interventions succeed in changing the determinants of one energy balance-related behavior, determinants of other related behaviors might also change. So far, however, intrapersonal determinants have usually been studied for one behavior at a time. A few studies have simultaneously examined the intrapersonal determinants across multiple lifestyle behaviors (Emmons et al., 1994; King et al., 1996; Herrick et al., 1997; Boek et al., 1998; Boyle et al., 1998; Doherty et al., 1998; Boudreaux et al., 2003). These studies have focused on behavioral risk factors for cardiovascular disease, such as smoking, diet and exercise. As yet, no study to our knowledge has specifically examined clustering of intrapersonal determinants in an energy balance approach. The present study examined the clustering of five energy balance-related behaviors (i.e., consumption of energy-dense snacks, the use of high-fat sandwich fillings, fruit consumption, active transport and physical activity during leisure time) and their intrapersonal determinants in a large sample of Dutch adolescents. The Theory of Planned Behavior (Ajzen, 1988) was used as the theoretical framework. In this framework, the concepts of attitude, subjective norm and perceived behavioral control are distinguished as determinants of intention, while intention is viewed as the primary determinant of behavior. The Theory of Planned Behavior predicts that individuals will be more likely to intend to engage in a particular behavior if they evaluate it positively (i.e., have a positive attitude towards the behavior), when they feel that important others think they should do so (i.e., a positive subjective norm) and when they feel they are able to perform the behavior (a positive perceived behavioral control). A review of the applicability of the Theory of Planned Behavior to health-related behaviors (Godin and Kok, 1996) showed that the model is efficient for explaining energy balance-related behaviors, such as fruit consumption (Brug et al., 1995), consumption of sweet snacks (Sparks et al., 1992) and exercising (e.g., Yordy and Lent, 1993; Courneya, 1995; Ravis and Sheeran, 2003). We hypothesised that energy balance-related behaviors, as well as their underlying intrapersonal determinants, would cluster. There is evidence to suggest that affective beliefs play

a more significant role in energy balance-related behavior motivation than instrumental beliefs (Lowe et al., 2002). Therefore, we examined the affective and instrumental components of attitude separately.

METHODS

Respondents and Procedure

Data were collected at schools, using self-administered questionnaires. A total of 253 secondary schools (age range 12–18 years) in the Netherlands were randomly selected to participate in the study. Twenty-seven percent of these (68 schools) agreed to take part. The questionnaires were provided to a contact person of each school and each school was asked to distribute the questionnaires in two randomly selected classes. A total of 3859 Dutch adolescents completed the questionnaire. The study sample comprised 55.2% girls and the average age was 14.8 years (SD 41.6). A total of 84.1% were native inhabitants of the Netherlands, and 83.1% of the sample lived with both the father and the mother.

Questionnaire

The questionnaire included items on five energy balance-related behaviors; consumption of energy-dense snacks, the use of high-fat sandwich fillings, fruit consumption, active transport and physical activity during leisure time. Based on the theoretical framework, the questionnaire included direct measures of intentions, attitudes, subjective norms and perceived behavioral control regarding each behavior, as well as stages of change for engaging in each of the five behaviors.

Energy Balance-Related Behaviors

Dietary behaviors were assessed with questionnaire items derived from a validated food frequency questionnaire designed to assess the intake of total and saturated fat (Van Assema et al., 1992, 2001). Intake of energy-dense snacks was assessed by four items relating to the number of days a week on which the following specific snacks were consumed: fried snacks, nuts and potato chips, pastries and candy bars, and biscuits. For example: 'Think of an average week in the past weeks. On how many days did you eat biscuits during such a week?', with answering categories ranging from '0' to '7'. Additionally, respondents were asked to indicate the number of snacks they consumed on such a day. For example: 'How many biscuits did you eat on such a day?'. Frequency and quantity were multiplied to obtain estimates of the mean consumption of snacks per week.

Consumption of high-fat sandwich fillings was assessed by one item on the mean number of sandwiches that respondents ate on an average day: 'Think of an average day in the past weeks. How many sandwiches did you eat per day?', with answering categories ranging from '0' to '8 or more'. Five items assessed the number of sandwiches filled with cheese, meat, sweet products, chocolate paste and peanut butter. For example: 'On how many of those do you normally put cheese?', with answering categories ranging from '0' to '8 or more'. Two additional items asked respondents if they normally used butter or margarine on sandwiches and the type of butter or margarine they used. Finally, respondents were asked about the types of meat product they used most frequently on sandwiches. Van Assema and colleagues (2001) created an algorithm for calculating fat scores with respect to 19 categories of food items, including sandwich filling, ranging from zero (lowest fat intake) to five points (highest fat intake) (Van Assema et al., 2001, p. 380). The answers to the questions in our questionnaire were used to calculate the number of times that the maximum of five fat points (e.g., three or more sandwiches with fat meat products) was scored (for more information, see Van Assema et al. (2001).

With regard to fruit consumption, the respondents were asked to indicate the number of days per week on which they usually consumed fruit: 'How many days a week do you normally eat fruit?'. Additionally, they were asked to report the number of pieces of fruit they ate on such a day: 'How many pieces of fruit did you eat on such a day?', with answering categories ranging from '0' to '3 or more'. The answers to these items were multiplied to estimate the number of pieces of fruit consumed per week.

In the Netherlands, the bicycle is the most popular means of transport among children and adolescents. However, the use of mopeds is increasing, and adolescents are more often taken to school, hobby clubs and sports clubs by car or public transport. Active transport was measured by assessing the means of transport used to go to school, to sports clubs and to hobby clubs. For example: 'How do you usually go to school?', with answering categories 'by bicycle', 'by moped', 'by bus', and 'by car'. In addition, adolescents indicated whether or not they were a member of a sports club and/or a hobby club. When a respondent indicated that not he/she is a member of a sports club or a hobby club, this opportunity to use active transport was not taken into analyses. Students were allocated to one of the following three categories: those who never use a bicycle (1), those who occasionally use a bicycle (2) and those who always use a bicycle for transport (3).

Physical activity during leisure time was measured by asking respondents to indicate whether or not they engaged in any of 16 activities presented, such as walking, jogging and swimming, during an average month. In addition, we assessed the number of

Clustering of energy balance-related behaviors

minutes that the respondents engaged in these behaviors, during an average week: 'How many hours a week are you physically active, outside school?'. The total number of minutes spent on these activities was used as an estimate of physical activity during leisure time.

Intrapersonal Determinants

Attitude, subjective norm and perceived behavioral control were assessed by direct measures for each of the five behaviors. All items relating to the intrapersonal determinants were framed towards 'preventive behaviors' (i.e., consumption of fruit, eating no or few sandwiches with high-fat fillings, snacking little and not every day, using a bike for transport and being active during leisure time). For each of the behaviors, the affective component of attitude was measured on a five point scale by the item: 'Engaging in behavior x is "very pleasant" to "very unpleasant"'. The instrumental component was assessed on a five point scale by the item: 'Engaging in behavior x is "very good" to "very bad"'. Subjective norm was assessed for each of the behaviors by one item asking respondents to indicate whether important others thought they should engage in the behavior. Answering categories ranged from 'certainly' (+2) to 'certainly not' (-2). For each of the behaviors, perceived behavioral control was assessed by two items with five answering categories, assessing the perceived difficulty ('very easy' to 'very difficult') and the perceived ability ('sure I am able' to 'sure I am not able') to perform the behavior. Inter-item correlations ranged from .69 for high-fat sandwich fillings to .78 for fruit consumption. Mean scores were computed for perceived behavioral control. Intention was assessed by one item, asking respondents to indicate their intention to engage in the behavior within the next six months. Answering categories ranged from 'yes, certainly' (+2) to 'no, certainly not' (-2).

ANALYSES

Three sets of analyses were conducted. First, we calculated bivariate correlations between the five behaviors, as well as between the intrapersonal determinants of these behaviors (intention, attitude, subjective norm and perceived behavioral control). Second, the clustering of intrapersonal determinants was studied, irrespective of potential clustering of the behaviors, by computing partial correlations for the intrapersonal determinants, while adjusting for the five behaviors. Third, partial correlations between attitude, subjective norm and perceived behavioral control were adjusted for the five behaviors as well as for the intention to engage in these behaviors. We used the magnitude of the effect size (r and partial r) as a source of information, since it is insensitive to group sizes (Tabachnick and Fidell, 1996). Effect size interpretations were based on Cohen's (1988) descriptive

guidelines. A large effect size was defined as a correlation of larger than or equal to 0.50. Correlations between 0.30 and 0.50 are regarded as medium effects sizes, while a small effect size is defined as a correlation of larger than or equal to 0.10. With respect to partial r 's, a small effect size was defined as larger or equal to 0.02, a medium effect size as larger than 0.15 and a large effect size as larger or equal to 0.35.

RESULTS

Energy Balance-Related Behaviors

The mean number of pieces of fruit per week was 7.72 ($SD = 45.72$). The respondents reported a mean number of snacking occasions per week of 10.54 ($SD = 45.03$). A total of 39.0% reported eating at least one sandwich per day with a high-fat filling. More than one fifth of the total sample (20.8%) indicated they never used a bicycle for transport, while 42.4% occasionally used a bicycle and 36.8% of the total sample always used a bike for transport. The adolescents reported that they were active for an average of 35.11 ($SD = 431.51$) minutes per day. Table I shows the effect sizes for the potential clustering of the five energy balance-related behaviors included in the present study. Two clusters were identified with correlations larger than 0.1. Fruit consumption was found to be positively associated with physical activity during leisure time, and snacking behavior was positively related to using high-fat sandwich fillings. The effect sizes were small.

Intention

Unlike the behaviors, all energy balance-related intentions did show correlations larger than 0.10. (Table 14). Effect sizes were again small, except for the cluster relating to intentions towards using less high-fat sandwich fillings and less snacking. The effect size remained large after adjustment for behavior. The other partial r 's for intention could be interpreted as medium effect sizes, except for the cluster of fruit consumption and the cluster of physical activity and snacking, which remained small after adjustment for behavior.

Attitude, Subjective Norm and Perceived Behavioral Control

All behavior-specific cognitions were found to have a correlation of 0.15 or larger. (Table 14). The effect sizes differed considerably across behaviors and across constructs. Although no large effect sizes were identified, five clusters were found to have a medium effect size. Correlations decreased when they were subsequently adjusted for the behaviors, and for the behaviors and intentions, but effect size interpretations revealed that most clusters had medium effect sizes after adjustment for both behavior and intention. The

cluster of perceived behavioral control regarding snacking and the use of high-fat sandwich fillings was found to have a large effect size.

DISCUSSION

Many health promotion efforts have focused on changing single health behaviors. Even in the weight management literature, a focus on energy balance, that is, targeting energy input as well as energy expenditure behaviors, has only recently been rigorously explored (NHIS, 1997; WHO, 1997; Jacobson, 2002). The present study among Dutch adolescents found that some energy balance-related behaviors, but especially intrapersonal determinants regarding these behaviors, are likely to cluster. Effect sizes of intrapersonal clusters ranged from small to large, with most clusters having medium effect sizes. These results provide initial cross-sectional information on the operation of synergistic cognitive motivational mechanisms within energy balance-related behaviors. Previous studies on clustering have reported particularly on biological risk factors (e.g., Raitakari et al., 1994; Milligan et al., 1995; Twisk et al., 1999; Chen et al., 2000) and behaviors (e.g., Raitakari et al., 1995; O'Neil et al., 1997; Ma et al., 2000). A review by Walker and Sefton (1994) found that effect sizes with regard to clustering of physical activity and dietary practices were small. We also found small effect sizes with respect to behavioral clustering of energy input and output behaviors. In parallel with Schuit and colleagues (2002), the present study showed that low levels of fruit and vegetable consumption clustered with low levels of physical activity in a Dutch sample. Our study may help to translate the outcomes of such epidemiological studies in the field of health promotion.

In recent years, some studies have focused on the simultaneous examination of cognitive variables such as attitude and self-efficacy across multiple lifestyle behaviors (King et al., 1996; Herrick et al., 1997; Boudreaux et al., 2003). These studies have largely focused on the potential clustering of smoking and exercise cognitions, and showed statistically significant correlations between attitudes and self-efficacy expectations regarding these behaviors. However, as Boudreaux and colleagues (2003) have pointed out, the effect sizes for these correlations were modest. The present study shows that cognitions regarding diet and exercise might be more closely related than those regarding smoking and exercise. The results indicate that clustering may be stronger within a behavioral domain (i.e., within the dietary domain or within the activity domain) than across the domains. On the other hand, partial correlations with medium effect sizes were repeatedly identified across domains. The present study does not provide definite insights into stronger and weaker clusters of energy balance-related motivations, but the results may

Table 14. Correlations for energy balance-related behaviors (B), intentions (I), instrumental attitudes (IA), affective attitudes (AA), subjective norms (S), and perceived behavioral control (P). Bivariate (unadjusted) correlations are depicted, as well as partial correlations, adjusted for behavior and for both behavior and intention (continued on page 135)

	Less snacking			Less high-fat and- with filling			Active transport			Physical Activity		
	Unadj	Adj for B	Adj for B and I	Unadj	Adj for B	Adj for B and I	Unadj	Adj for B	Adj for B and I	Unadj	Adj for B	Adj for B and I
Fruit												
B	.54			.66			.70			.11		
I	.33	.17		.27	.20		.20	.19		.21	.14	
IA	.19	.14	.11	.22	.16	.12	.19	.14	.09	.22	.17	.13
AA	.23	.20	.18	.20	.17	.15	.18	.17	.15	.25	.23	.20
S	.21	.21	.20	.21	.21	.19	.24	.25	.23	.31	.30	.28
P	.16	.13	.14	.21	.17	.20	.17	.15	.17	.19	.16	.15
Less snacking												
B	.14	.18		.14	.18		.02	.14		.07		
I	.25	.28	.22	.26	.28	.22	.16	.14	.09	.17	.15	.11
IA	.35	.34	.26	.35	.34	.26	.17	.14	.14	.16	.15	.15
AA	.40	.39	.26	.40	.39	.26	.22	.20	.14	.19	.19	.15
S	.29	.29	.26	.29	.29	.26	.19	.18	.16	.24	.24	.23
P	.39	.35	.36	.39	.35	.36	.15	.14	.16	.15	.16	.17

Table 14. Correlations for energy balance-related behaviors (B), intentions (I), instrumental attitudes (IA), affective attitudes (AA), subjective norms (S), and perceived behavioral Control (P). Bivariate (unadjusted) correlations are depicted, as well as partial correlations, adjusted for behavior and for both behavior and intention (continued from page 134)

	Less snacking			Less high-fat sandwich filling			Active transport			Physical Activity		
	Unadj	Adj for B	Adj for B and I	Unadj	Adj for B	Adj for B and I	Unadj	Adj for B	Adj for B and I	Unadj	Adj for B	Adj for B and I
Less high-fat sandwich fillings												
B							.01			-.07		
I							.19	.16		.20	.17	
IA							.19	.16	.10	.17	.16	.09
AA							.21	.19	.12	.19	.20	.14
S							.18	.17	.16	.26	.25	.24
P							.19	.17	.19	.17	.17	.15
Active transport												
B										.04		
I										.22	.17	
IA										.26	.21	.15
AA										.27	.24	.16
S										.36	.35	.31
P										.38	.24	.25

r > .10 = small effect size; r > .30 = medium effect size; r > .50 = large effect size
Partial correlations: r > .02 = small effect size; r > .15 = medium effect size; r > .35 = large effect size

guide the formation of hypotheses in future investigations.

Studies of relevant predictors of health behavior are often based on null hypothesis significance tests. If p -values are below 0.05, variables are labelled as 'significantly predictive'. However, null hypothesis significance tests are highly dependent on sample size. With large samples, even a small difference between two groups will easily exceed the 0.05 criterion. Such a significant result does not give any information on the practical relevance of the particular variable. Since there is always some correlation between two variables, a large enough sample will always lead to a significant result (see also Cohen, 1994). Since our sample was large, we used effect sizes to interpret our data (see also Tukey, 1962; Cohen, 1994). The conclusions on the effect sizes were based on Cohen's (1988) descriptive guidelines. The effect size values served as operational definitions of the qualitative adjectives 'small', 'medium', and 'large'. Although Cohen (1988) indicated that the definitions of effect size conventions "*will be found reasonable by reasonable people*", like all statistical conventions (such as the $p < 0.05$ level), these definitions are arbitrary. We adjusted the clusters of intention for potential clustering in behavior, and we adjusted the clusters of attitude, subjective norm and perceived behavioral control for both intention and behavior. Adjusting correlations for factors that have a shared or overlapping variance leads to an underestimation of the real correlation (Tabachnick and Fidell, 1996). Therefore, the tests of our hypotheses may be regarded as conservative, since specific intrapersonal determinants and behavioral acts are often closely interrelated (e.g., Bagozzi, 1981; Kraus, 1995). Presentation of bivariate correlations only would not have provided information on the role of the corresponding behavioral acts in the explained variance. Since we were interested in the general adolescent population rather than in possible differences in clustering relating to the respondents' demographic characteristics, we did not introduce such factors in our analyses.

The present study is subject to various limitations. A total of 73% of the approached schools refused to participate in the study. As main reasons for non-participation, school directors reported to have a full curriculum, or they were already participating in other scientific studies. However, a comparison of school types of participating and non-participating schools did not reveal any systematic refusal. A second limitation is the measurement of the intrapersonal variables. Both components of attitude, as well as subjective norm and intention have been assessed with single items, which decreased the reliability of the analyses. Moreover, the potentially important social cognitive constructs of descriptive norm (Rivis and Sheeran, 2003), group norms (Johnson and White, 2003) and controllability (Ajzen, 2002) were not included in the study. Thirdly, correlations across

the behavioral measures may have been negatively influenced by the differences in scaling methods. Active transport was measured on a three-point scale, while other behaviors were assessed with frequency measures. In contrast, the constructs from the Theory of Planned Behavior were assessed with similar scales. The measurement and categorization of the energy balance-related behaviors require further comment. It has been shown that individuals are not always able to accurately report their dietary behaviors and physical activity behaviors (Lechner et al., 1997; Lechner et al., 1998; Ronda et al., 2002). This lack of awareness of personal behavior may have reduced the validity of our results. Including more objective measures of these behaviors in the study design might lead to the observation of stronger clusters of energy balance-related behaviors.

The cognitive clusters found may have been caused by various processes. For example, it is possible that individuals have a general readiness to change, suggesting similar motivations and cognitions for each behavior (King et al., 1996). Changes in motivational constructs regarding one energy balance-related behavior may also occur simultaneously with changes in motivational constructs regarding other energy balance-related behaviors. In contrast, various authors have suggested a sequential process (Abrams, 1992; King et al., 1996), in which an increase in the level of motivation for one behavior may produce progressive changes in motivation towards engaging in other behaviors at a later time. However, the cross-sectional nature of our data precludes any conclusion about the underlying causal processes. The results illustrate the advantages of studying dietary behavior and physical activity in an energy balance approach. This implies that multiple behaviors need to be studied, relating to both energy input and energy output. However, this may lead to a measurement problem. Measuring complete belief structures of multiple behaviors requires very long questionnaires, which may result in low response rates, annoyed respondents and a low validity of the data. Instead, we advocate the measurement of the direct constructs, along with intention and energy balance-related behaviors. When insights are gained into the main determinants of the various behaviors in the at-risk group of the population of interest, researchers should direct their focus to the salient beliefs that underlie these determinants in order to inform intervention development.

We would like to make a final comment about the advantages of using the energy balance approach. These advantages apply not only to the study of behavioral determinants. Interventions that aim at the prevention of obesity in adolescents may also profit from applying this approach, rather than focusing on either dietary behavior or physical activity. On the one hand, the fact that weight gain is induced by multiple dietary and physical activity behaviors may complicate the prevention of weight gain. Compared to

the other main behavioral cause of ill health, smoking (where smoking cessation is the single behavioral goal), changing energy balance-related behavior may be regarded as much more complex. However, an advantage of the energy balance approach lies in the fact that some individuals might be interested in reaching energy balance by changing their snacking behavior, while others might be more inclined to change their level of physical activity during leisure time. Offering a target group the possibility of choosing how to maintain their energy balance will constitute an attractive feature for intervention designers trying to achieve the prevention of obesity. Moreover, since cognitive factors were found to cluster across energy balance-related behaviors, a positive change in intrapersonal determinants of one behavior might induce a similar change in the related construct for another behavioral determinant of the energy balance. For example, successfully changing one behavior could boost perceived behavioral control for both that behavior and other behaviors. This, in turn, could enhance the motivation to change the second behavior (King et al., 1996). The principle of these synergistic effects forms a potentially effective ingredient of health promotion programmes aiming to prevent weight gain.

Chapter 9

Does habit strength moderate the intention-behavior relationship
in the Theory of Planned Behavior? The case of fruit consumption

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ABSTRACT

The present study examined if habit strength moderated the influence of intention on fruit consumption in a Dutch adult sample ($N = 521$, 46.3% males, Mean age = 34.50, $SD = 10.87$), using the theoretical relations of the Theory of Planned Behavior (TPB). TPB variables and habit strength were assessed at baseline. Fruit consumption was assessed with a validated questionnaire five weeks later. Three groups were created: low habit strength ($n = 180$), medium habit strength ($n = 185$) and high habit strength ($n = 156$). Confirmatory factor analyses and multi-group path analyses were performed using AMOS 4.0. A good fit was obtained for the overall measurement model and the structural models. Multi-group path analyses showed that intention was a significant predictor of fruit consumption in the low habit ($\beta = .36$, $p < .001$) and medium habit group ($\beta = .30$, $p < .001$), but a non-significant predictor in the high habit group ($\beta = .05$, $p = .596$). Implications for information-based and motivation-based interventions are discussed.

INTRODUCTION

The currently available scientific evidence provides a sufficiently strong and plausible basis to justify the systematic development of intervention programs to increase healthy nutrition behaviors (World Health Organization, 2003), such as an adequate consumption of fruit. A high consumption of fruit is associated with lower risk of cancers and, since fruits are a valuable source of dietary fibre, may protect against weight gain and obesity (Kremers, Visser, Brug, Chin A Paw, Schouten, Schuit, Seidell, Van Baak, Van Mechelen, Kemper, Kok, Saris and Kromhout, 2005; Kromhout, Bloemberg, Seidell, Nissinen, and Menotti, 2001; World Health Organization, 2003). Nevertheless, in most countries, only a small minority eats according to the recommended intake levels for fruits (Netherlands Nutrition Centre, 2003; World Health Organization, 2003). In order to develop interventions aiming to increase fruit intake, determinants of fruit intake need to be identified (Green and Kreuter, 1999). The Theory of Planned Behavior (TPB) (Ajzen, 1991) has been used extensively in the identification of determinants of a wide range of behaviors (Bamberg, Ajzen and Schmidt, 2003; Blanchard, Courneya, Rodgers, Daub and Knapik, 2002; Conner, Norman and Bell, 2002; Courneya, Conner and Rhodes, 2006; De Bruijn, Kremers, Schaalma, Van Mechelen and Brug, 2005; Gredig, Nideroest and Parpan-Blaser, 2006; Kassem and Lee, 2004; Norman, Conner and Bell, 1999; Norman and Smith, 1995), including fruit consumption (Bogers, Brug, Van Assema and Dagnelie, 2004; Lien, Lytle and Komro, 2002). The TPB posits that the most proximal determinant of behavior is the intention to perform this behavior. In turn, intention is theorized to be predicted by three social-cognitive concepts, namely attitude, subjective norm and perceived behavioral control (PBC). Attitude refers to the favourable or unfavourable evaluation a person has towards the behavior, with both cognitive and affective evaluations of behavior of importance (Ajzen, 2001; Courneya, Conner and Rhodes, 2006; Van der Pligt, Zeelenberg, Van Dijk, De Vries and Richard, 1998). Subjective norm refers to the perceived social pressure to perform or not to perform the behavior, while PBC is a person's belief as to how easy or difficult performance of the behavior is likely to be and to what extent performance is under one's control (Ajzen and Madden, 1986). When PBC matches actual behavioral control, PBC is theorized to have a direct influence on behavior.

Notwithstanding the supportive evidence from systematic reviews and meta-analyses for the use of TPB in understanding human health behavior (Armitage and Conner, 2001; Godin, 1993; Godin and Kok, 1996; Hagger, Chatzisarantis and Biddle, 2002; Hausenblas, Carron, Mack and Godin, 1997), recent calls have been made to extend the TPB to include additional factors (Conner and Armitage, 1998). For instance, Trafi-

mow (2000) argued for the addition of habit. However, the concept of habit is relatively underrepresented in social-psychological determinants research (Aarts, Verplanken and Van Knippenberg, 1998), presumably because the measurement of habit has long been an underdeveloped issue (Verplanken and Orbell, 2003). Traditionally, habit has been measured by the number of times that behavior has already been performed in the past by an individual (Triandis, 1977). Evidence to date indicates direct effects of past behavior on current behavior, even when TPB cognitions are taken into account (Conner and Abraham, 2001; De Bruijn, Kremers, Lensvelt-Mulders, De Vries, Van Mechelen, Brug, 2006; Hagger et al., 2001; Jackson, Smith and Conner 2003; Norman and Smith, 1995; Rhodes and Courneya, 2003). However, the reasoned action perspective of the TPB does not see a necessary link between frequency of past behavior and the habitual level of that behavior (Ajzen, 2002a). Prior behavior may predict later behavior because of other, unmeasured factors that are stable over time and thus influence behavior on both occasions (Aarts et al., 1998; Bamberg et al., 2003; Eagly and Chaiken, 1993). Additionally, the effect of prior behavior may reflect common method variance (Ajzen, 1991) since similar response formats are generally used for behavioral assessment at both time-points. Consequently, behavioral recurrence does not constitute direct evidence for habitual processes (Ajzen, 2002a; Bamberg et al., 2003; Verplanken and Orbell, 2003). Verplanken and Orbell (2003) have argued that habit is a psychological construct rather than behavioral recurrence and, based on earlier discussions (Bargh, 1994; Verplanken and Aarts, 1999), posited that habit is a mental construct that involves lack of awareness, difficulty to control, mental efficiency, and repetition. In accordance, Verplanken and Orbell (2003) developed the Self Reported Habit Index (SRHI), a 12-item measure constructed to tap these four dimensions. The SRHI may provide helpful insight into the relation between past and current behavior. For instance, Verplanken (2006) found that habit strength, assessed with the SRHI, mediated the effect of past snacking behavior on current snacking behavior, indicating that habit is a viable explanation of the residual variance problem (Ajzen, 2002a). Additionally, Brug, De Vet, De Nooijer and Verplanken (2006) found that the addition of habit strength in a hierarchical regression equation significantly increased explained variance in fruit intake and fruit intake intentions.

Perhaps of even more theoretical and practical relevance may be the process by which two variables interact to influence another variable (Sutton, 1998). In this respect, Triandis (1977; 1980) has hypothesized that habit should interact with intention in the prediction of behavior. More specifically, Triandis argued that when habit strength for a certain behavior increases, this behavior should be less guided by conscious intentions.

Although interactions or so-called moderator analyses are relatively infrequent in the literature (Sheeran, 2002), examining the interaction of habit and intention is a useful complement to demonstrations that behavior is a matter of habit or intention. Consequently, habit may put a boundary limitation of the applicability of the TPB (Aarts et al., 1998). This proposed moderation of the intention-behavior relation has been shown before. Using a response-frequency measure to assess habit strength, Aarts et al. (1998) and Verplanken, Aarts, Van Knippenberg and Moonen (1998) provided evidence that intentions became less predictive of active transport mode choice when habit strength for that particular behavior increased. However, this response-frequency measure has been criticized by Ajzen (2002a), arguing that this measure is best interpreted as a generalized intention. Moreover, response-frequency measures require a controlled research environment and may not be suitable for applied research (Norman and Conner, 2005). In contrast, the SRHI does not require these highly controlled research environments and thus provides a suitable instrument to stimulate the further development of theory and research on habit (Verplanken and Orbell, 2003).

Interaction or moderation may be tested in several ways (Baron and Kenny, 1986; Frazier, Barron and Tix, 2004; Holmbeck, 1997). Arguably the most commonly used strategy is to compute an interaction term that is the product of the two centred main effects, which is entered in an hierarchical regression analysis. Statistically significant interactions terms are then interpreted using simple slope analyses. In addition to simple slope analyses, structural equation models are increasingly being encouraged in the study of potential moderators (Aiken and West, 1991; Baron and Kenny, 1986; Holmbeck, 1997). Structural equation modeling has some advantages over multiple regression analyses. First, they allow for the assessment of latent variables free of measurement error. Additionally, they provide statistical significance tests for theorized relations in the model, while also providing information on the overall model fit. In order to investigate interaction effects using structural equation modeling, a multi-group approach can be used to investigate if values for parameters vary across categorical variables (Byrne, 2004; Kline, 2005). If these parameters (for instance, the intention-behavior relationship) significantly differ across groups (for instance, categories of habit strength), the categorical variable is thought to act as a moderator.

The purpose of the present study was to investigate if habit strength would moderate the intention-behavior relationship with regard to fruit consumption. To our knowledge, this is the first study to investigate the moderation effect of habit strength using the SRHI through multi-group structural equation modeling.

METHODS

Subjects and procedures

For the present study, respondents between the ages of 18 and 55 years were derived from a larger longitudinal cohort study on determinants of fruit consumption in a random sample of a Dutch Internet panel (for study details, see De Vet, De Nooijer, De Vries and Brug, 2005). This panel consisted of 8165 members at the time of the study who had indicated to become a panel member on the website of Flycatcher Internet Research BV. The total panel consisted of 43% males with a mean age of 33.04 years ($SD = 13.02$). Of the panel members, 23%, 37% and 40% had a low, medium or high level of education respectively. The sample for the present study consisted of 521 respondents, consisting of 46.3% males. Mean age was 34.50 ($SD = 10.87$). Habit strength and TPB-variables were assessed at T1, while fruit consumption was assessed 5 weeks later.

Measures

Fruit consumption was assessed with a five-item questionnaire, which was validated against seven-day dietary records and biomarkers for fruit intake (Bogers, Van Assema, Kester, Westerterp and Dagnelie, 2004; Van Assema, Brug, Ronda, Steenhuis and Oenema, 2002). Respondents were asked to indicate on how many days per week (0 = 'never/less than once per month'; 7 = 'seven days per week') they consumed the following fruits: tangerines, citrus fruits (such as oranges, grapefruits and lemons), apples or pears, bananas, and other fruits (such as preserved fruits). Additionally, respondents were asked to indicate the number of servings they consumed on such a day. Multiplying frequency with the reported usual amount and dividing that score by seven calculated an average amount of pieces of fruit per day.

TPB cognitions and habit strength were assessed at T1 regarding the Dutch guidelines for fruit consumption of at least two pieces per day (Netherlands Nutrition Centre, 1998). Intention was assessed with two items ('I intend to eat two pieces of fruit per day in the next four weeks' and 'I am sure I will eat two pieces of fruit per day in the next four weeks') on five point Likert scales (+2 = totally agree; -2 = totally disagree). Cronbach's alpha was .93. Based on Conner and Sparks (1996), four items were used to assess the cognitive and the affective aspects of attitude. The cognitive aspect of attitude towards fruit consumption was assessed with two items on five-point Likert scales, tapping the good-bad aspect (+2 = very good; -2 = very bad) and the healthy-unhealthy aspect (+2 = very healthy; -2 = very unhealthy) regarding the statement 'I believe eating two pieces of fruit per day is'. Cronbach's alpha was .77. Affective attitude towards fruit consumption

was assessed with two items on five-point Likert scales, tapping the pleasant-unpleasant aspect (+2 = very pleasant; -2 = very unpleasant) and the tasteful-tasteless (+2 = very tasteful; -2 = very tasteless) regarding the statement 'I believe eating two pieces of fruit per day is'. Cronbach's alpha was .86. Subjective norm was assessed with the item 'people who are important to me believe I should eat at least two pieces of fruit per day' on a five-point Likert scale (+2 = totally agree; -2 = totally disagree). PBC was assessed with six items on five-point Likert scales (+2 = very easy; -2 = very difficult) about the perceived difficulty of eating at least two pieces of fruit per day in specific situations (during the weekend; during weekdays; during the winter; in lack of time; in emotional stress; starting to get ill). Cronbach's alpha was .87.

Habit strength related to fruit consumption was assessed using the 12 items from the SRHI (Verplanken and Orbell, 2003) at T1. Respondents were asked to indicate the extent to which they agreed (+2 = totally agree; -2 totally disagree) with the following statements: eating fruit is something (1) I do regularly, (2) I do automatically, (3) I do without having to consciously remember, (4) that makes me feel weird if I do not do it, (5) I do without thinking, (6) that would require effort not to do it, (7) that belongs to my routine, (8) I start doing before I realize I am doing it, (9) I would find hard not to do, (10) I have no need to think about doing, (11) that is typically me, and (12) I have been doing for a long time. Cronbach's alpha was .96.

Based on the suggestions by Cohen (1983), three groups for habit strength were created based on one standard deviation from mean score for habit strength. However, this resulted in rather large group size differences. Since unequal sample sizes across groups leads to decreased power to detect parameter differences (Alexander and DeShon, 1994), groups were differentiated based on half a standard deviation from mean score for habit strength, resulting in similar group sizes. Low habit strength was defined as lower than or equal to mean score minus 0.5 standard deviation ($n = 180$), medium habit strength as between 0.5 standard deviation above/below mean ($n = 185$) and high habit strength as equal to or higher than 0.5 standard deviation above mean ($n = 156$).

Analyses

Multivariate analyses of variance with Tukey-HSD contrasts were conducted to test for differences in fruit consumption and TPB-variables between the three groups. In order to test for multi-group differences regarding the intention-behavior relationship, Structural Equation Modeling (SEM) was performed using AMOS 4.0. Since there were some missing responses (< 1%), full-information maximum likelihood (FIML) was used to esti-

mate parameters. FIML is an optimal method for treatment of missing data (Kaplan, 2000) and has shown more accurate fit indices than pair-wise deletion, list-wise deletion or mean-imputation (Nunnally and Bernstein, 1994). Because maximum-likelihood estimation tends to overestimate test statistics for non-normal data (Curran, West, and Finch, 1996), the normality of the items and variables used were investigated in terms of its skewness and kurtosis. Non-normality was indicated by skewness >2 and kurtosis >7 (West, Finch, and Curran, 1995).

Several fit indices were used to assess model fit. The most commonly used fit index is the chi-square test, which tests the adequacy of the theorized model's covariance matrix in comparison with the observed covariance matrix. Nevertheless, the chi-square test has been criticized for its dependence upon sample size and inclusion of absolute and incremental fit indices is recommended (Bollen, 1989; Jöreskog, 1993), so additional indices are recommended (Hu and Bentler, 1999). The root mean square of error approximation (RMSEA) (Browne and Cudeck, 1993) was used as an absolute fit index, while the NFI and CFI (Bentler, 1990) were used as indexes of incremental fit. An adequate model fit is obtained when the NFI and CFI are greater than .90 (Bentler, 1990) and the RMSEA is less than .08, while a good model fit is obtained when the NFI and CFI are greater than .95 and the RMSEA is less than .05 (Hu and Bentler, 1999). We additionally used the Akaike Information Criterion (AIC) and the Expected Cross-Validation Index (ECVI) to test model fit between competing models. The AIC and ECVI are generally used in SEM to select among competing non-hierarchical models estimated with the same data. The model with the smallest AIC and ECVI value is considered to demonstrate the best fit, since lower values indicate an improved and more parsimonious fit (Kline, 2005).

Based on the recommended two-step approach by Anderson and Gerbing (1988), the measurement model and structural model were constructed separately. In the first step, Confirmatory Factor Analysis (CFA) was used to test an overall measurement model. This measurement model linked the observed variables to their related latent constructs and consisted of four latent variables (i.e. affective attitude, cognitive attitude, PBC, and intention) and two indicators (i.e. subjective norm and fruit consumption), which were all allowed to correlate. The latent variable PBC consisted of six indicators, while the latent variables intention, cognitive attitude and affective attitude consisted of two indicators each. For each latent variable, the loading of the first indicator was set to 1 in order to create its metric. In the second step, the adequately defined measurement model was used for the path analyses in the structural model. Four structural models

were tested, based on the relations posited in the TPB. Model 1 assumed no differences in the intention-behavior relationship across the three habit groups (a-a-a). The fit indices for this a-a-a model served as the baseline value against which model fit for the other two models was compared. Model 2 assumed a difference in the intention-behavior relationship between the low habit strength and medium habit strength group compared with the high habit strength group (a-a-b). Model 3 assumed a difference in the intention-behavior relationship between low habit strength group compared with the medium and high habit strength (a-b-b), while model 4 assumed differences in the intention-behavior relationship across the three groups (a-b-c). Since this involved testing in nested models, the likelihood-ratio test or chi-square difference test (Bollen, 1989) was used. Cohen's effect sizes were used as the informational source for the explanatory value of the models (Cohen, 1988).

RESULTS

Descriptives

Table 15 provides descriptives for and bivariate correlations between the study variables. For the total group, mean habit strength was slightly below mid-scale ($M = .30$, $SD = 1.04$), with mean fruit consumption 1.18 pieces of fruit per day ($SD = 1.01$). Twenty-seven percent met the Dutch recommended guidelines for two pieces of fruit per day. Tukey-HSD contrasts showed that the high habit group had a significantly, $F(2, 521) = 57.87$, $p < .001$, higher intention towards fruit consumption (mean = 1.39; $SD = .95$) than the medium (mean = .53; $SD = .95$) and low habit group (mean = .19; $SD = 1.16$). Furthermore, the low habit group consumed significantly, $F(2, 521) = 103.30$, $p < .001$, less fruit ($M = 0.65$, $SD = 0.80$) than the medium habit group ($M = 1.10$, $SD = 0.86$), while the medium habit group consumed significantly less fruit than the high habit group ($M = 1.91$, $SD = 0.96$). Eight percent of the low habit group, eighteen percent of the medium habit group and fifty percent of the high habit group met the recommended level of fruit consumption per day, respectively.

Measurement model

Normality was met for all items (range skewness = -1.24 to .49; range kurtosis = -1.13 to 1.89), except for fruit consumption (skewness = 2.65; kurtosis = 4.33). Since fruit consumption was moderately skewed, square root transformation was used (Tabachnick

Table 15. Descriptives and bivariate correlations for total sample, low habit strength (15A), medium habit strength (15B), and high habit strength (15C) (continued on Page 151)

Total Sample (n=321)		1	2	3	4	5	6	7	8	9
1	Fruit	Mean (SD)	1							
2	Intention	1.18 (1.01)	1							
3	AA	.67 (1.14)	.42***	1						
4	CA	.67 (0.91)	.41***	.53***	1					
5	SN	1.32 (0.71)	.19***	.34***	.44***	1				
6	PBC	.03 (1.28)	.12**	.23***	.05	.12**	1			
7	Habit	-.03 (1.06)	.30***	.60***	.20***	.02	.71***	1		
8	Age	.30 (1.04)	.54***	.64***	.18**	.06	.15**	.12**	1	
9	Gender	34.48 (10.85)	.09*	-.04	-.19***	-.09*	-.09*	-.21***	-.21***	1
			.12**	.05	.19***	-.05	-.09*	-.06	.07	.03
			1	3	4	5	6	7	8	9
15A Low Habit (n=180)		1	2	3	4	5	6	7	8	9
1	Fruit	Mean (SD)	1							
2	Intention	.65 (0.80)	1							
3	AA	.20 (1.16)	.32***	1						
4	CA	.06 (0.83)	.08	.41***	1					
5	SN	1.25 (0.73)	.06	.27***	.27***	1				
6	PBC	.02 (1.38)	.11	.24**	.05	.14	1			
7	Habit	-.30 (0.70)	.16*	.20**	.31**	-.03	.05	.32***	1	
8	Age	-.40 (0.44)	.13	.42***	.43***	.03	.05	.07	.10	1
9	Gender		.00	-.01	-.22**	-.26**	-.11	-.14	-.03	-.12***
			.02	.23**	.25**	.05	.01	.03	.03	.01

AA = Affective attitude; CA = Cognitive attitude; SN = Subjective norm; PBC = Perceived Behavioral Control
*** p < .001; ** p < .01; * p < .05

Table 15. Descriptives and bivariate correlations for total sample, low habit strength (15A), medium habit strength (15B), and high habit strength (15C) (continued from page 150)

15B Medium (n = 185)		Mean (SD)	1	2	3	4	5	6	7	8	9
1	Fruit	1.10 (.86)	1								
2	Intention	.53 (.095)	.23**	1							
3	AA	.67 (.073)	.21**	.34***	1						
4	CA	1.20 (.70)	.06	.29***	.53***	1					
5	SN	-.11 (.23)	.08	.36***	.01	.06	1				
6	PBC	.04 (.06)	.15*	.22**	.30***	.15	.00	1			
7	Habit	-.29 (.29)	.09	.08	.11	-.14	.05	.11	1		
8	Age	34.31 (11.08)	.03	-.18*	-.14	-.22	-.14	.01	.06	1	
9	Gender		-.06	.12	-.04	-.04	.08	-.02	-.05	-.20**	1
15C High (n = 156)		Mean (SD)	1	2	3	4	5	6	7	8	9
1	Fruit	1.01 (.096)	1								
2	Intention	1.39 (.095)	.23**	1							
3	AA	1.38 (.066)	.24**	.39***	1						
4	CA	1.54 (.061)	.24**	.34***	.53***	1					
5	SN	.20 (.12)	.10	.06	-.01	.11	1				
6	PBC	.95 (.072)	.44***	.48***	.58***	.32***	.01	1			
7	Habit	.96 (.032)	.45***	.32***	.39***	.25*	-.04	.39***	1		
8	Age	36.13 (11.83)	.09	.03	.01	-.16*	-.04	.23**	.18*	1	
9	Gender		.01	.18*	.25**	.31***	-.11	-.05	.16*	-.22**	1

AA = Affective attitude; CA = Cognitive attitude; SN = Subjective norm; PBC = Perceived Behavioral Control
*** p < .001; ** p < .01; * p < .05

and Fidell, 2000). After transformation, an acceptable normal distribution was obtained. The initial overall measurement model provided a good fit to the data $\chi^2(64, N = 521) = 245.87, p < .001, NFI = .97, CFI = .98, RMSEA = .07, AIC = 355.87, ECVI = .68$, but included one PBC-item ('starting to get ill') with a factor loading $< .40$. Removal of this item resulted in a good model fit, $\chi^2(52, N = 521) = 166.58, p < .001, NFI = .98, CFI = .98, RMSEA = .06, AIC = 270.58, ECVI = .52$, with all factor loadings $> .65$. Mean scores, standard deviations, factor loadings and interfactor correlations for this final overall measurement model are shown in Table 16.

Structural model

The baseline model, in which the intention-behavior was parameter was constrained to be equal across the three habit groups (a-a-a), provided good fit to the data, $\chi^2(167, N = 521) = 354.33, p < .001, NFI = .95, CFI = .97, RMSEA = .05, AIC = 644.33, ECVI = 1.24$. Contrasting the high habit group with the low and medium habit group for the intention-behavior parameter (a-a-b) significantly increased model fit, $\Delta\chi^2(1, N = 521) = 7.67, p = .001$, compared with the baseline model. Contrasting the low habit group with the medium and high habit group (a-b-b) also significantly increased model fit, $\Delta\chi^2(1, N = 431) = 6.36, p = .01$, when compared with the baseline model. Allowing the three parameters to be unequal across the three groups (a-b-c) also significantly increased model fit, $\Delta\chi^2(2, N = 431) = 9.08, p = .02$. Investigating AIC and ECVI values revealed the most parsimonious fit for the a-a-b model. This model provided good fit to the data, $\chi^2(166, N = 521) = 346.66, p < .001, NFI = .95, CFI = .98, RMSEA = .04, AIC = 638.66, ECVI = 1.23$, and is shown in Figure 11. Intention was a significant predictor of fruit consumption in the low habit ($\beta = .36, p < .001$) and medium habit ($\beta = .30, p < .001$) group, but intention did not significantly predict ($\beta = .05, p = .596$) fruit consumption in the high habit group.¹ The model explained 14 percent variance in fruit consumption in the low and medium habit group, and 21 percent variance in the high habit group, indicating medium effect sizes (Cohen, 1988).

DISCUSSION

According to the TPB, intention is hypothesized to be the most immediate determinant of human behavior, yet several recent lines of research suggest that intentional control of behavior may be more limited than the TPB assumes (Sheeran, 2002). The present study

¹ Similar results were found when tertiles for habit strength were used. Low habit: $\beta = .34, p < .001$; medium habit: $\beta = .26, p < .001$; high habit: $\beta = .06, p = .493$. Model fit: $\chi^2(166, N = 521) = 334.64, p < .001, NFI = .96, CFI = .98, RMSEA = .04, AIC = 626.64, ECVI = 1.21$

Fruit consumption and habit strength

Table 16. Mean scores, standard deviations, factor loadings, and interfactor correlations from the overall measurement model

		Mean (SD)	Factor loading	1	2	3	4	5	6
1	Fruit	1.18 (1.01)		1					
2	Intention		.91***		1				
	<i>I intend to eat</i>	.68 (1.15)	.96***						
	<i>I am sure I will eat</i>	.66 (1.20)							
3	Perceived Behavioral Control					1			
	<i>during weekdays</i>	.14 (1.24)	.90***				.24***	.65***	.00
	<i>during the weekend</i>	.09 (1.21)	.83***						
	<i>when in lack of time</i>	-.34 (1.15)	.73***						
	<i>during the winter</i>	.12 (1.17)	.88***						
	<i>when in emotional stress</i>	.03 (1.05)	.67***						
4	Cognitive attitude						1		
	<i>good-bad</i>	1.29 (.79)	.81***					.54***	.13**
	<i>healthy-unhealthy</i>	1.35 (.78)	.78***						
5	Affective attitude							1	
	<i>pleasant-unpleasant</i>	.50 (1.02)	.88***						.06
	<i>tasteful-tasteless</i>	.84 (.93)	.86***						
6	Subjective Norm	.03 (1.28)							1

*** $p < .001$; ** $p < .01$; * $p < .05$

investigated whether this intentional control of fruit consumption was moderated by habit strength, as assessed with the SRHI. Results showed that the influence of intention on fruit consumption was weak and non-significant for those who had a strong habit towards fruit consumption. In contrast, for those with a low or medium habit strength towards fruit consumption, intention was a significant predictor of fruit consumption. The results found are in line with empirical evidence (Aarts et al., 1998) and theoretical reasoning (Triandis, 1977; 1980). Notably, our results seem to underline the apparent boundary limitation (Aarts et al., 1998) of intention as the primary determinant of behavior, at least with regard to fruit consumption. For those with low / medium habit strength, path analyses confirmed the reasoned, intentional process for fruit consumption. In contrast, for those with high habit strength, PBC had the strongest influence on behavior. Thus, perceived

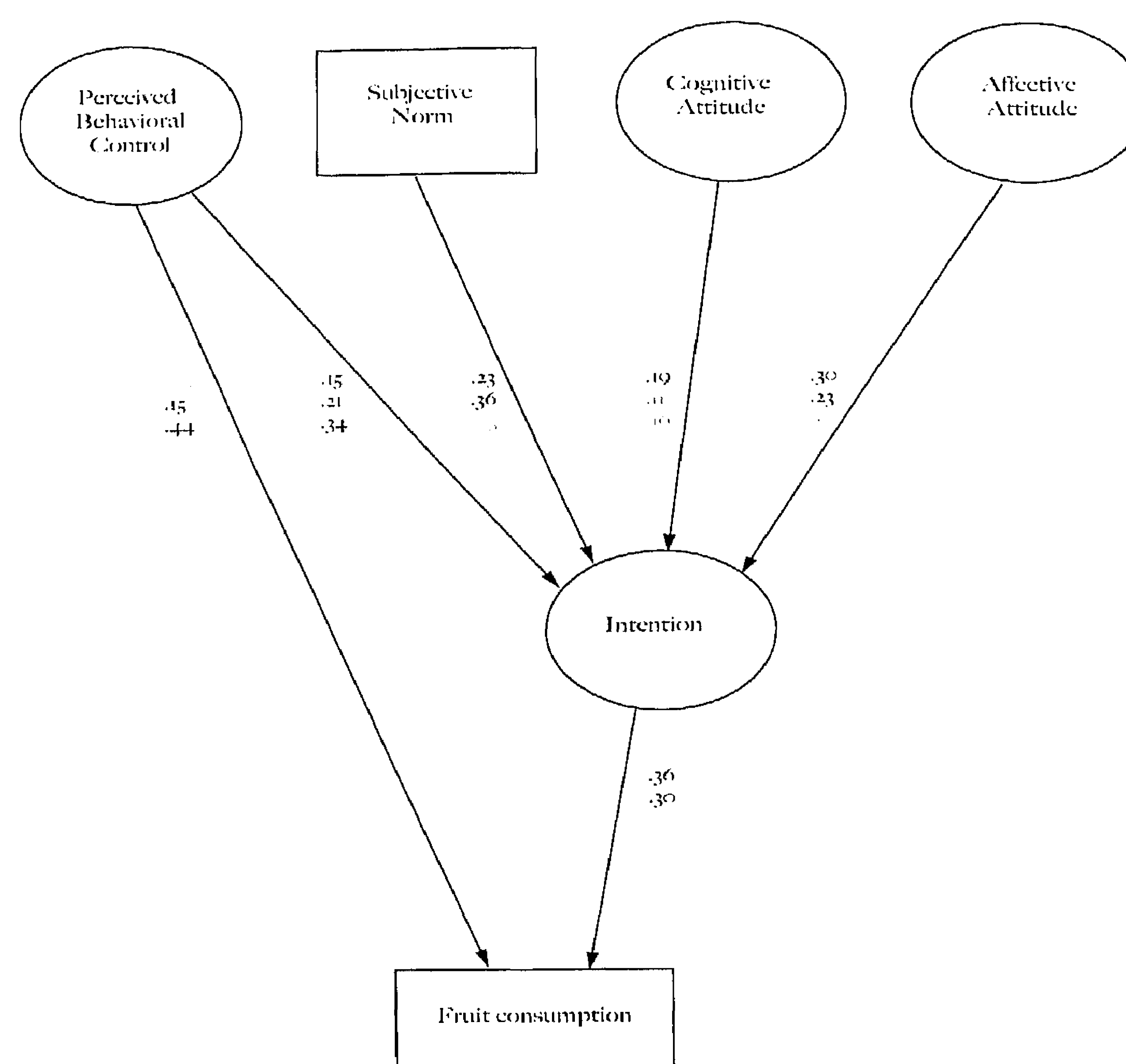


Figure 11. Standardized regression coefficients for final multigroup model. Circles represent latent variables; squares represent observed variables. Top values indicate path coefficients for low habit group; middle values indicate path coefficients for medium habit group; bottom values indicate values for high habit group. For reasons of clarity, covariances and uniquenesses are now shown.
Overall model fit: $\chi^2(166, N=521) = 346.66, p < .001$; Normed Fit Index = .95; Comparative Fit Index = .98; Root Mean Square Error of Approximation = .04; Akaike Information Criterion = 638.66; Expected Cross-Validation Index = 1.23. *** $p < .001$; ** $p < .01$; * $p < .05$

controllability of fruit consumption seems to overrule the planned and intentional processes of fruit consumption for those with a strong habit. Within the TPB, PBC refers to people's beliefs about the presence of internal as well as external factors that may further or impede performance (Ajzen, 2002b). Since the increase in unhealthy dietary behaviors in recent years is likely to be partly attributable to an obesogenic environment (World Health Organization, 2003), in which an unhealthy diet is facilitated by easy access to palatable high-energy, high saturated fat foods, control of dietary behavior may nowadays be more

influenced by external factors in the obesogenic environment. The environment-behavior link also relates to the origins of habit, which are thought to originate from repeated performance of a given behavior in a stable situational context. Upon entering that specific situation, habits induce behavior through the automatic activation of mental representations of that behavior (Aarts and Dijksterhuis, 2000; Ouellette and Wood, 1998; Verplanken and Aarts, 1999). Importantly, strong habits may provide a plausible explanation for the small to moderate effects TPB-based interventions tend to have on health behavior change (Hardeman, Johnston, Johnston, Bonetti, Wareham and Kinmonth, 2002). Interventions based on the TPB have generally used informational strategies, i.e. providing people with information about the risks and outcomes of behaviors in order to promote more positive attitudes and intentions toward behavior change. Nevertheless, models of persuasion predict that providing information will only result in attitudinal change and subsequent behavioral change if one is likely to pay attention to the new information and is able to actively process it (Chaiken, 1980; 1987). However, research indicates that strong habits are associated with limited and selective information processing, because persons with strong habits tend to use heuristic and low effort strategies rather than cognitively demanding strategies (Aarts, Verplanken and Van Knippenberg, 1997; Verplanken and Aarts, 1999). Notably, this selective information processing is irrespective of levels of knowledge and previous experience. The increased focus on the habitually chosen option (Aarts et al., 1998) may thus override reasoned considerations regarding increasing fruit consumption. Consequently, even for those who habitually eat fruit, but less than recommended, informational and motivational-based interventions may not result in increased fruit consumption. Hence, the modest and short-lived effects of TPB-based interventions may be related to enduring physical environments in which sufficient fruit is unavailable. Findings in the physical activity domain have found that such environmental influences shape the return to previous behavior when the intervention is over (Gauvin, Levesque and Richard, 2001; Laitakari, Vuori and Oja, 1996). Consequently, health behavioral change for those with strong habits may be more dependent upon environmental manipulations, i.e. making healthy foods more readily available. Indeed, recent reviews have found several successful environmental interventions to increase fruit intake (De Bruijn, Kremers, Wendel-Vos, Van Lenthe and Brug, 2005; Kremers, De Bruijn, Droomers, Van Lenthe and Brug, 2005).

The present study is subject to certain limitations. First, respondents were drawn from an existing Internet panel and, although high response rates can be established with web-based surveys (Couper, 2000), external validity may be reduced. For

instance, higher educated people and respondents younger than 30 were overrepresented in our sample, which should caution generalizability of the results found. Second, since no validated cut-off points exist at present for differentiating groups with regard to habit strength, we constructed groups based on standard deviations from mean score for habit strength. While similar results were found when tertiles for habit strength were used, the lack of a validated cut-off point for habit strength may lead to data-driven definitions of low versus high habit strength. Finally, TPB variables were assessed regarding the Dutch norm for fruit consumption (i.e. do you intend to eat at least two pieces per day?) but these variables were used to predict a linear outcome variable (i.e. total pieces of fruit consumption). This discrepancy violates the principle of compatibility, which underlines the need for intention and behavior to be compatible in terms of action, target, context and time (Ajzen, 1988; Courneya, 1994). More compatible measures between intention and fruit consumption may have attenuated the differences between the three groups.

In sum, our results have indicated that intentional control of fruit consumption is dependent upon habit strength. Future research should investigate whether the SRHII moderates the intention-behavior relationship in other health-related behaviors.

Chapter 10
General Discussion

Chapter 10
General Discussion

INTRODUCTION

This thesis reports on several studies that were conducted as part of the NHE-NRG research program (Kremers et al., 2005a) that was initiated in order to inform innovative efforts to prevent weight gain in three distinct target groups: (1) adolescents, (2) young adults, and (3) recently retired. The purpose of this thesis was to explore and model potentially relevant environmental and personal determinants of EBRBs. Because most studies reported in this thesis used existing data, only a limited number of potential environmental variables was investigated.

This final chapter is divided into several parts. First, the main findings of this thesis are summarized. Next, methodological issues pertaining to the design of the studies and the measurement and analytical rationale are discussed, followed by implications for practice and theory. In the final section of this chapter, the results of the studies outlined in this thesis are integrated in a conceptual research framework, which may be helpful in guiding future determinant and intervention research on EBRBs.

PART I: PHYSICAL ENVIRONMENTAL INFLUENCES ON EBRBs

In Chapter 2, a conceptual model proposed by Van Lenthe and Mackenbach (2002) formed the basis of our analysis plan. In their model, a causal process is outlined that may account for neighborhood disparities in obesity and coronary heart disease prevalence rates and that are often reported in the epidemiological research field (Diez-Roux, 2001, 2002; Diez-Roux et al., 1997; Van Lenthe & Mackenbach, 2002). In line with earlier findings (Van Lenthe & Mackenbach, 2002), those living in neighborhoods of low socio-economic status had an almost threefold increased chance for obesity when compared with those living in high socio-economic status neighborhoods. However, this neighborhood effect was only found among men. Next, it was found that low socio-economic status neighborhoods had significantly higher crime rates and household density than high socio-economic status neighborhoods. In men residing in low socio-economic status neighborhoods, these higher crime rates were associated with less cycling and higher BMI. Crime rates and cycling explained 13 percent of the variance in BMI, indicating a medium effect size.

To explore the potential mediating role of action-specific cognitions in the environment-bicycle use relationship, Chapter 3 reports on a study of bicycle use for transportation purposes (e.g., going to school or sports club) amongst Dutch adolescents. Chapter 3 also reports on the potential role of environmental factors in the associations

with adolescent snacking behavior. Results of this study showed that the environmental factors included in this study were more relevant for bicycle use than for snacking behavior. Results showed that adolescents who went to school in a less-urbanized town were nearly twice as likely to use their bicycle for transportation purposes. Variables from the Theory of Planned Behavior (TPB) related to bicycle use were insufficient to account for the association between degree of urbanization and bicycle use. The final model explained of the 29 percent variance in bicycle use, indicating a medium effect size.

The first part of this thesis ended with Chapter 4, in which findings based on a conceptual model for the explanation of adolescent physical activity were presented. This conceptual model combined physical activity in the past, social cognitions related to physical activity and several environmental factors known to be relevant for physical activity (i.e. aesthetics and local facilities). Using a structural equation modeling approach, results showed that past physical activity had the strongest association with current physical activity. Also, intention to be physically active was not significantly associated with physical activity, suggesting the possible habitual nature (see also Chapter 9) of adolescent physical activity. Effect size for the explanatory value of the model was medium.

PART 2: SOCIAL ENVIRONMENTAL INFLUENCES ON EBRBS

The second part of this thesis reports on two studies that have explored influences from the social environment on EBRBs. Based on Darling and Steinberg's model on parental influences (Darling & Steinberg, 1993), Chapter 5 reported on a study investigating the role of parenting practices and their relation with adolescent soft drink consumption. Although Darling and Steinberg's model hypothesizes that adolescent personality may moderate this relationship, empirical evidence for this proposition was lacking. Chapter 5 therefore also explored the potential moderating role of adolescent personality regarding the parenting practices – adolescent soft drink consumption relationship. In line with previous findings regarding other health behaviors (Davison et al., 2003; De Bourdeaudhuij & Van Oost, 1996; De Bourdeaudhuij, 1997; Huver et al., 2006), but contrasting those of others (Birch et al., 1987; Fisher & Birch, 1999), results showed that adolescents who perceived their parents to have stricter house rules regarding soft drink consumption drank less soft drink. Importantly, the personality dimension Agreeableness moderated this relationship, with adolescents with medium levels of Agreeableness most likely to obey parental house rules. Effect size for the model was medium.

Chapter 6 reports on the relative influences of situation-specific self-efficacy beliefs, and different types and sources of social support on adult moderate and vigorous

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physical activity. Although social support has been found to be a consistent correlate of physical activity, studies to date have generally not differentiated between sources and types of social support, while these studies also tend to have focused on vigorous physical activity. Differentiating between these sources and types of social support showed different associations for different sources and types of social support with moderate and vigorous physical activity. Notably, self-efficacy expectations were unable to fully mediate these influences for moderate physical activity and only partially mediated these influences for vigorous physical activity. Effect sizes were small for moderate and medium for vigorous physical activity.

PART 3: ADDITIONAL INDIVIDUAL-LEVEL INFLUENCES ON EBRBs

The final part of this thesis explored several potentially relevant individual-level influences on EBRBs. In Chapter 7, associations between Big Five personality dimension and several EBRBs (i.e. fruit consumption, vegetable consumption, and physical activity) were investigated in a sample of Dutch adolescents (see also Chapter 5 for associations between Big Five and soft drink consumption). Results showed that the personality dimensions Openness to Experience and Agreeableness were significantly and positively associated with fruit and vegetable consumption, while the personality dimension Extraversion was significantly and positively associated with sports-related physical activity. Effect sizes for these associations were small.

Chapter 8 focused on the potential clustering effect of several EBRBs and their respective intrapersonal social-cognitive variables in adolescents. Findings indicated the co-occurrence of fruit consumption and leisure time physical activity, and of snacking behavior and consumption of high-fat sandwich fillings. Stronger co-occurrence was found for the cognitive intrapersonal determinants of behaviors than for the behaviors themselves. Small to medium effect sizes were found for the associations.

The final chapter of Part 3 investigated the potential important moderator role of habit strength in the intention-behavior relationship regarding fruit consumption. In line with the hypotheses by Triandis (1977, 1980), intention was a non-significant predictor of fruit consumption for those with a strong habit towards fruit consumption. In contrast, intention was a significant predictor for fruit consumption for those with a modest or a low habit strength related to fruit consumption. Explanatory value for the model was of medium effect size.

METHODOLOGICAL ISSUES

The findings described above should be viewed in the light of several methodological limitations. These limitations pertain to issues regarding assessment, analyses and study design, and explained variance. Below, these issues are outlined in more detail.

ASSESSMENT ISSUES

Social-cognitive variables

One of the key assumptions in the TPB is that attitude, subjective norm, PBC, and intention should be assessed at the same level of specificity to ensure the most accurate prediction of behavior. Initially termed the 'correspondence principle' (Ajzen & Fishbein, 1980; Fishbein & Ajzen, 1975) (Ajzen renamed it the 'compatibility principle' in 1988 (Ajzen, 1988)), it underlines the need for the TPB concepts to agree on the following four elements: (1) the action, (2) the target at which the action is directed, (3) the context in which the action takes place, and (4) the time at which the action is performed. For instance, if one wants to accurately predict my listening to Mozart's Piano Concerto in C-minor tonight when I am at home, the intention measure should specify action (listening), target (Mozart's Piano Concerto in C-minor), time (tonight) and context (at home). Hence, the best intention measure should be framed 'I intend to listen to Mozart's Piano Concerto in C-minor tonight when I am at home' as opposed to the global motive 'I intend to listen to Mozart tonight', or, even more globally, 'I intend to listen to classical music'. Although the relations between these concepts and the predicted behavior increases largely when assessed at the same level of specificity (Davidson & Jaccard, 1975; Fishbein & Ajzen, 1975;), the correspondence principle is violated in numerous studies (see also (Courneya & McAuley, 1993)), increasing the likelihood that the prediction of the behavior under study from the predicting TPB-variables to be low.

In the studies reported in this thesis, the correspondence principle issue was also not met, albeit to various degrees across the separate studies. For instance, the bicycle-use related cognitions in Chapter 3 complied with the action (i.e. bicycle use) and the context (for transportation purposes) but failed to specify the target and time criteria. Also, fruit consumption-related cognitions described in Chapter 9 only specified the action (eating two pieces of fruit per day) and time (in the next four weeks). Finally, the soft drink consumption cognitions (Chapter 5) and the physical activity cognitions (Chapter 4 and 6) only acknowledged the action criteria. As a result, associative and mediating power of social cognitions may have been limited in the reported studies. However, following these assessment guidelines may yield practical problems, because the assessment of

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various EBRBs and their respective cognitive determinants will cause questionnaires to be long, which may lead to annoyed respondents, low response rates and invalid data. This may necessitate a more pragmatic approach (Kremers et al., 2005b). Kremers and colleagues (2005b) argue for a measurement approach of cognitive determinants, in which attitude, subjective norm, PBC, and intention are assessed through direct measures (i.e. good-bad; easy-difficult). When cognitive determinants are significantly related to the behavior under study, only then specific beliefs underlying these direct constructs need to be identified. Note that this recommendation is in line with earlier suggestions (Ajzen & Fishbein, 1980; Ajzen, 2002a).

Perceived Behavioral Control versus Self-Efficacy

Although the primary theoretical model used in this thesis (i.e. Theory of Planned Behavior) acknowledges Perceived Behavioral Control (PBC) as an antecedent of intention and behavior, Chapter 6 explored the potential mediating role of self-efficacy, rather than PBC, in the social support-physical activity relationship. At first thought, this distinction may seem trivial, since Ajzen (1991) initially viewed PBC as synonymous with Bandura's self-efficacy. However, concerns have been expressed regarding this proposed similarity (Conner & Armitage, 1998; Manstead & Van Eekelen, 1998). These concerns primarily focus on Ajzen's (1991) description of PBC, which was thought to reflect both actual control (the resources and opportunities available to a person, such as money, time and skills) and perceived control (the ease or difficulty of performing the behavior). On a more global level, it may represent the distinction between internal factors (i.e. perceived control) and external factors (i.e. actual control). In an experiment amongst 135 undergraduate students, Trafimow and colleagues (2002) found that artificially manipulating external factors (i.e. suppose there was a 0%; 50%; 98% chance that a 10 km run would be cancelled due to rain) had a significant effect on control (how much would completing the race be under your control?) but not on difficulty (how much would completing the race be easy to do?). In contrast, manipulating internal factors (i.e. suppose you were assigned to read a 1; 30; 100 page(s) from your textbook next week) had a significant effect on difficulty (how much would reading the assignment be easy to do?) but a significantly attenuated effect on controllability (how much would reading the assignment be under your control?). The distinction between external and internal factors in PBC does not appear in self-efficacy, which only focuses on internal factors. As argued by Bandura (1992), locus of control has little or no relation with self-efficacy. Perceived control therefore resembles Bandura's definition of self-efficacy (Bandura, 1997).

The distinction into actual control and perceived control implies that PBC may be separated into two different processes (Conner & Armitage, 1998; Trafimow, Sheeran, Conner, & Finlay, 2002). For instance, studies in the physical activity domain (Motl et al., 2002; 2005) indicated that PBC was associated with, and predicted changes in vigorous physical activity. In contrast, self-efficacy did not significantly predict changes in vigorous physical activity, although cross-sectional associations were found between self-efficacy and vigorous physical activity. Self-efficacy and PBC may therefore not be redundant in explaining physical activity and, consequently, these constructs are likely to be influenced by different interventions (Motl et al., 2002; Trafimow, Sheeran, Conner, & Finlay, 2002). According to Social Cognitive Theory (Bandura, 1997; 1998), self-efficacy is developed by four main sources of influence: (1) mastery experiences, (2) vicarious experiences, (3) social persuasion, and (4) somatic and emotional states. These factors can be influenced by interventions that target observational learning, exertion and persuasion (Bandura, 1997) all of which can be quickly manipulated in physical activity settings (Motl et al., 2002). On the other hand, PBC reflects beliefs about the presence or absence of requisite resources and opportunities (Ajzen, 1991), some of which rely on external environmental influences which are not easily targeted in focused and short-term interventions (Motl et al., 2002; 2005). Because the discussion on the possible redundancy between self-efficacy and PBC continues to be unresolved to this date (Ajzen, 2002a; Armitage, 2005; Bandura, 2004; Motl et al., 2005), future studies should continue manipulating these different control processes to draw more definite conclusions about which factors are actually controlling the EBRBs of concern (Conner & Armitage, 1998; Trafimow, Sheeran, Conner, & Finlay, 2002).

SELF-REPORTS

Because it is virtually impossible to obtain objective measures of health-related behaviors (Ajzen & Fishbein, 2004), determinant and intervention studies on EBRBs generally use self-reports. Nevertheless, self-reports are known to be biased by several factors. Below, issues concerning self-reports of behavior and environmental factors are discussed.

Self-reported behavior

Reporting on one's frequent behavior (e.g. daily physical activity or soft drink consumption) generally suffers from fragmented recall, because frequent behaviors blend into generic, knowledge-like representations that lack time and space that hamper accurate recall and forces respondents to rely on an estimation strategy. This estimation effect leads

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to an exaggeration of, or reduction in, actual frequency of behavior (Schwarz, 1999). As a result of such probable biases, several strategies have been employed to test the validity of questionnaires, including those used in the studies conducted as part of this thesis.

For instance, a validation study, in which the questionnaire employed in this thesis to assess fruit and vegetable consumption in adolescents (Chapter 7) and adults (Chapter 9) was compared with biomarkers (plasma concentrations of vitamin C and carotenoids), indicated this questionnaire to be suitable for ranking individuals according to their fruit and vegetable intake (Bogers, Van Assema, Kester, Westerterp, & Dagnelie, 2004). Validation studies for the questionnaire used to assess physical activity in the Amsterdam Growth and Health Longitudinal Study (AGAHLS-PAQ) have shown good validity (Kemper, 2004). Furthermore, the questionnaire used to assess physical activity for the studies conducted in Chapter 4 and 7 was validated in an adult sample against a 7-day physical record and indicated reasonable validity (Spearman rank-order coefficient = .50; Cohen's kappa = .33) and test-re-test reliability (Spearman rank-order coefficient = .73; Cohen's kappa = .58) (Koremans, Derks, Tuinstra, Diederiks, & Brug, 2000; Ronda, Van Assema, & Brug, 2001). Similarly, the LASA Physical Activity Questionnaire (LASA-PAQ) (Chapter 2) has been found to correlate highly ($r = 0.68$) with a 7-day diary and to correlate moderately ($r = .56$) with wearing a pedometer. Additionally, repeatability was reasonably good for this questionnaire (Stel et al., 2004). Importantly, both the LASA-PAQ and the AGAHLS-PAQ were assessed in a face-to-face interview, which is thought to provide a more valid account of physical activity levels than self-administered questionnaires (Montoye, Kemper, Saris, & Washburn, 1996). In sum, even though concerns have been expressed with regard to the validity of self-reported behavior, questionnaires are thought to be practical assessment methods in epidemiological studies that are sufficiently valid (Ainslie, Reilly, & Westerterp, 2003; Bloek, 2001; Byers, 2001).

Self-reported physical environmental influences

In contrast to the objective measures used in transportation and planning research efforts, evidence in the health promotion research field indicating that the environment is conducive to physical activity has been largely based on subjective perceptions of the environment (Brug & Van Lenthe, 2005; Kirtland et al., 2003; Saelens, Sallis, & Frank, 2003). Indeed, in a review study on the associations between environmental factors and adult physical activity, only four out of nineteen studies used objective measurements of the environment (Humpel, Owen, & Leslie, 2002). Although some physical environmental attributes are very difficult to measure objectively (such as aesthetics) (King et al., 2005),

little is known about the accuracy of such subjective survey data (Kirtland et al., 2003; Sallis et al., 1997), possibly because standardized survey measures in the physical environmental domain are not yet well established (Owen, Humpel, Leslie, Bauman, & Sallis, 2004; Saelens, Sallis, & Frank, 2003). However, the use of objective measures is limited as well. For instance, in a study assessing objective environmental features in relation to walking, King and colleagues (2005) defined walking distance as 1500 meters from participants' home, derived from geocoded addresses. It is, however, likely that 1500 meters may have been a walkable distance for some, but not for others. As argued in Chapter 4, self-efficacy beliefs determine how one perceives environmental barriers and opportunities. To summarize, the development of objective measures of environmental factors is an important direction for research (Humpel, Owen, & Leslie, 2002; Saelens, Sallis, & Frank, 2003), as well as studies that compare self-reported perceptions with objective environmental indices (such as those derived from Geographic Information Systems (GIS) databases) (Owen, Humpel, Leslie, Bauman, & Sallis, 2004) and assess their relative and surplus value in the explanation of EBRBs.

Explained variance

Researchers in the field of health education, as in many other behavioral scientific fields, have often relied on the amount of explained variance to denote the explanatory value of their predictor variables or their conceptual model. The percentage of variance explained is accepted as a good measure of the relevance of explanatory factors (see Abelson, 1985 and Rosenthal, 1990 for illuminative views on the relevance of small percentages explained variance). When the amount of explained variance is deemed insufficient, theoretical and empirical attempts are frequently made to extend existing models by incorporating additional variables for the purpose of explaining more of the variance in the behavior of interest (Sutton, 1998). Recently, Trafimow (2004) convincingly pointed out the serious problems this paradigm brings with it and even remarked "*studies ... would advance the field of psychology to a far greater extent if researchers abandoned it*" (p. 515). In the same line of thought, Sutton (1998) claims that increasing the amount of explained variance by adding more variables might be useful, but explaining more variance hardly contributes to our understanding why and/or how these additional factors relate to the behavior under study. Moreover, if the development of causal models is our main aim, researchers should look and carefully specify the process by which two or more variables act in combination to influence another variable and miniscule values for percentage explained variance should not be reasons for concern (Abelson, 1985; Sutton, 1998). Thus, while the amount

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of explained variance in the studies described in the earlier chapters usually did not exceed a third of the total variance, these small to medium effect sizes (Cohen, 1988) may nevertheless be useful. To illustrate, Chapter 9 will serve for this purpose. Using similar data from the cohort studied in this Chapter, Brug and colleagues (2006) used hierarchical regression analyses to assess the surplus value of habit strength over TPB-variables in the prediction of intention of fruit consumption and actual fruit consumption and concluded that, because habit proved to have additional explanatory value, future studies should focus on the *role* (italics added) habit strength plays in dietary behaviors. Note that the role played by habit refers to a need for understanding how habit influences dietary behaviors. Findings discussed in Chapter 9 provide some evidence for the role habit plays in the intention-behavior relationship. While sufficiently explanatory, results from Chapter 9 should be viewed in the context of understanding the role of habit, rather than the earlier reported increment in explained variance due to the addition of habit. Similarly, Chapter 5 provided a plausible account for the earlier-reported inconsistent results found in the parenting practices – adolescent health behavior relationship. Therefore, an explanatory model should have wider implications and greater strategic value than a purely predictive model because it does not only tell us what to target, but also who to target and what to do with them (Sutton, 1998). Furthermore, emphasizing the relative importance of particular effects, perhaps most notably between personality dimensions and social-cognitive factors, may be trivial: any nonzero effect of a personality characteristic on any outcome measure may lead to large increases in terms of population outcomes (Abelson, 1985; Ozer & Benet-Martinez, 2006).

Cross-sectional designs

As is common in the social sciences (Blossfeld & Rohwer, 1995), most of the studies reported in this thesis used cross-sectional data and, no matter how advanced the statistical methods used to analyze cross-sectional data, causal conclusions are difficult to draw. Therefore, caution is needed to interpret some of the findings reported in the previous chapters. For instance, results from Chapter 5 were presented to demonstrate that adolescent soft drink consumption was influenced by soft drink related practices, but several studies show that parents reactions are mutually influenced by adolescent behavior (Engels, Finkenauer, Kerr, & Stattin, 2005; Ennet, Bauman, Foshee, Pemberton, & Hicks 2001). Similar concerns should be expressed regarding social cognitions: in low-involvement situations, individuals may not go through a deliberate process of attitude formation but may base their attitudes on previous experiences with a particular behavior.

These inverse cognition-behavior relationships are, for instance, described in the concept of dissonance reduction (Festinger, 1957). Chapter 5 also showed that subjective norms regarding soft drink consumption were inversely related with soft drink intake, which is not in line with the hypothesized positive associations outlined in the TPB. It may be that high intake triggers subjective norms to be more negative towards intake.

IMPLICATIONS OF THE FINDINGS

The exploration of potential personal and environmental determinants of energy-balance related behaviors in the three target groups in this thesis had three main purposes: (1) to inform and guide the development of behavioral change interventions in order to prevent weight gain, (2) to model the potential direct influence of physical and social environmental factors on energy balance-related behaviors, and (3) to explore potentially important individual-level influences on energy balance-related behaviors. Thus, the studies reported in this thesis provide both practical and theoretical implications for weight-gain prevention efforts. In the course of the following sections, these two categories of implications are discussed.

THEORETICAL IMPLICATIONS OF THE STUDY FINDINGS

An important part of this thesis involved exploring potentially important individual-level influences on EBRBs. Several issues pertaining to the assumptions of the TPB were explored. Below, the concepts habit and personality are discussed in some detail and recommendations are made for their inclusion in health promotion theory. Both parts start off with quotes from Ajzen and Fishbein.

Habitual tendencies

In one of their earlier works, Fishbein and Ajzen (1975) suggest that “*a person may intend to perform one behavior, by force of habit he may perform an alternative one*” (pp. 371).

The notion of habit dates back as far as the last decade of the nineteenth century, when William James (1890) emphasized that living creatures are “a bundle of habits that cover a very large part of life”. In the behaviorist tradition, habits have been a focal point of attention (Hull, 1943; Watson, 1914). However, with the publication of Skinner’s ‘Verbal Behavior’ (Skinner, 1957), the demise of behaviorist approaches in psychology was irreversible and with it scientific interest for habitual processes in the psychological research field.

In the last decades, habitual processes have started to reemerge as an important construct in psychology and health behavior (Aarts, Paulussen, & Schaalma, 1997; Aarts,

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Verplanken, & Van Knippenberg, 1998; Ouellette & Wood, 1998; Triandis, 1977, 1980; Verplanken, Aarts, Van Knippenberg, & Moonen, 1998; Verplanken and Orbell, 2003). Our contention for the incorporation of habitual processes in the determinant studies regarding EBRBs is not new (Conner & Armitage, 1998; Hagger, Chatzisarantis, & Biddle, 2002; Trafimow, 2000), but what appears to be lacking is a valid measure of habit. In the 'second coming' of habit, it has traditionally been equated with frequency of past behavior in survey-based research. According to the TPB, the role of past behavior is a test of sufficiency of the theory, because past behavior should theoretically lead to increased perceptions of control and therefore influence current behavior (largely) through PBC and intention (Ajzen, 1991). However, when a measure of past behavior is included in addition to intention and other TPB-variables, the effects of intention tend to diminish or even disappear (Hagger, Chatzisarantis, Biddle, & Orbell, 2001; Ouellette & Wood, 1998; Rhodes & Courneya, 2003a). But, as repeatedly stressed (Ajzen, 2002b; Eagly & Chaiken, 1993; Verplanken & Aarts, 1999), past behavior is an 'empty construct': a proxy variable from a multitude of psychological factors that may generate behavioral consistency (Ouellette & Wood, 1998). What is needed is an independent measure of habit that is more than behavioral recurrence (Bamberg, Ajzen, & Schmidt, 2003). Based on earlier discussions (Bargh, 1994; Verplanken & Aarts, 1999), this independent measure was developed by Verplanken and Orbell (2003) and named the 'Self-Reported Habit Index' (SRHI). The results described in Chapter 9 clearly indicate that, once fruit consumption has become habitual, intentional effects on behavior diminish drastically. Importantly, behaviors that are guided by strong habits are difficult to suppress (Aarts & Dijksterhuis, 2000) and subject to limited information-processing regarding alternative behavioral options (Aarts, Verplanken, & Van Knippenberg, 1997; Verplanken, Aarts, Van Knippenberg, & Moonen, 1998). The use of the SRHI as a means to demonstrate the boundary limitation of the TPB (Aarts, Verplanken, & Van Knippenberg, 1998) regarding the intention*habit interaction is still limited. Nevertheless, health behavioral theories should benefit from a further investigation of the potential moderating effect of the SRHI in the intention-behavior relationship regarding additional EBRBs now that a validated script-based measure of habit has become available.

Integrating personality dimensions

In the words of Ajzen and Fishbein (1980), "*it may neither be feasible nor of practical value to measure the intention in close proximity to the behavior. It may be important (...) to make predictions months or years in advance*" (pp. 47). Since health promotion is interest-

ed in determinants that accurately predict future behavior in order to administer the most effective interventions, the primary determinant in the TPB (i.e. intention) may not be best suited for predicting EBRBs over a prolonged period of time. Although Ajzen and Fishbein (1980) suggest measuring intentions conditional upon the occurrence of certain events (for instance, taking increases in the price of gasoline into account when predicting purchasing an automobile) to circumvent this problem, a potentially interesting route is to consider intra-individual consistencies in behavior that are relatively invariant over time and situations (i.e. the Big Five personality dimensions) (McCrae & John, 1992). There are several indications that personality configurations are stable (Santor, Bagby, & Joffe, 1997; Vaidya, Gray, Haig, & Watson, 2002), even across prolonged periods such as from childhood to adolescence (Caspi & Silva, 1995) and from adolescence to young adulthood (Roberts, Caspi, & Moffitt, 2001). In a comprehensive review, Roberts and DelVecchio (2000) reviewed 152 longitudinal studies and concluded that personality is quite consistent over the life course with no systematic consistency differences between men and women. Also, personality consistency relates to behavioral consistency (Caspi et al., 1997). A bulk of research indicates that personality influences health behavior and longevity (Caspi et al., 1997; Friedman & Booth-Kewley, 1987; Friedman et al., 1993; Friedman et al., 1995; Ozer & Benet-Martinez, 2006). For instance, higher levels of Extraversion and Conscientiousness predict longer lives (Danner, Snowdon, & Friesen, 2001; Friedman et al., 1995), while lower levels of Agreeableness predicts earlier mortality and poorer physical health (Miller et al., 1996). Furthermore, and perhaps of more relevance to this thesis, a recent longitudinal study (Brummet et al., 2006) showed that higher levels of Neuroticism and Extraversion were positively related to BMI, while higher levels of Openness to Experience, Conscientiousness and Agreeableness were inversely related to BMI. The link between personality and health outcomes may reflect a process in which personality influences behaviors that protect or diminish health (Ozer & Benet-Martinez, 2005). This influence may be direct (see Chapter 5 and 7) or indirect. For example, Extraversion is positively related to social support (Berkman, Glass, Brissette, & Secman, 2000), which in turn is positively related to health behaviors, such as physical activity (Chapter 6).

Because personality influences seem to occur to some extent independent of cognitive factors, additional mechanisms should be sought to account for these direct influences. One of the mechanisms might be related to biological processes. For instance, evidence provides a biological basis for Emotional Stability, Conscientiousness, and to a lesser extent for Agreeableness (Zachary et al., 2005). Recently, Wacker, Chavanon and Stemmler (2006), using Depue and Collins (1999) suggestions, found some evidence

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that Extraversion is in part based on dopamine, a neurotransmitter in the human brain. Results from Simonen and colleagues (2003), studying the relationship between dopamine D2 receptor gene and physical activity, suggest that increased dopamine levels in the brain, resulting from being physically active, lead to feelings of pleasure, therefore providing some indications that a genetic component may be involved in the explanation why certain individuals are more physically active than others. Likewise, others (Courneya et al., 2002; Eysenck, 1981; Rhodes & Courneya, 2003b; Rhodes et al., 2002a; Rhodes et al., 2002b) have suggested that individuals high on Extraversion more frequently seek out stimulating situations where opportunities to be physically active present themselves in order to compensate for the low internal arousal commonly found in extraverts (Courneya & Hellsten, 1998; Rhodes, Courneya, & Jones, 2002). In sum, while to date the influence of personality consistencies on EBRBs has generally been overlooked in favor of cognitive processes, inclusion of personality dimensions in addition to social cognitive factors may provide a more sufficient account of the determinants of health behavior (Conner & Abraham, 2001).

One issue regarding the personality – EBRBs link needs further commenting. The five-factor model assumes that the personality dimensions are non-health specific and thought to influence behavior through instrumental, experiential, and temperamental effects (Costa & McCrae, 1992). Even though several of these dimensions still showed small effect sizes in the explanation of specific EBRBs in this thesis, the Big Five may be either too broad or too global for allowing an adequate understanding for their role in specific EBRBs. Narrow trait measures may be more effective than broader measures (Ozer & Benet-Martinez, 2005). In fact, studies on academic achievement and personnel selection have found that the constituent traits of the Big Five dimensions (such as the trait Need for Achievement from the dimension Conscientiousness) are more predictive of course grades and job performance, respectively, than the broad measures (Paunonen et al., 1999; Paunonen & Ashton, 2001a, 2001b). While this research endeavor is only just getting started in the weight-gain prevention research field, support for this contention has been provided by Rhodes and colleagues (Rhodes, Courneya, & Jones, 2002; 2004; Rhodes & Courneya, 2003b). They found the 'activity' trait in the personality dimension Extraversion to be of particular relevance in the prediction of exercise behavior. Future research endeavors for understanding the personality-EBRBs should therefore focus on identifying the specific traits in these relevant dimensions that might maximize our understanding of the influences of personality dimensions on EBRBs.

PRACTICAL IMPLICATIONS OF THE STUDY FINDINGS

Traditional health educational programs to date have relied heavily on providing the target audience with relevant information to persuade them to behave in a more healthy fashion. In this route to persuasion, four steps are involved (Eagly & Chaiken, 1993): attending the message, understanding the message, accepting the message, and retaining the message. Underlying this tradition is the assumption in the dominant social-cognitive models that human beings are rationale agents that consciously perceive and interpret environmental events and act according to these perceptions and interpretations. EBRBs typically tend to be behaviors that are part of daily life routines and findings from the studies reported in the previous chapters indicate that this reasoned action perspective may be too limited and inadequate to gain a better understanding of the role of habitual and environmental influences on EBRBs. From these findings, the following practical implications are deducted.

Environmental interventions as an adjunct to individual interventions may increase the effectiveness of weight-gain prevention efforts

Since behavior-specific social cognitions were unable to mediate the influence of environmental factors on several EBRBs, environmental interventions should be considered as an important additional tool to promote weight-gain preventive behaviors in the populations studied in this thesis. This notion is, of course, by no means new. The last two decades have seen an increase of environmental manipulations designed to alter unhealthy behaviors in a more healthy direction. Although the potential effects of environmental interventions on EBRBs are usually smaller than those obtained from individually oriented interventions, environmental manipulations have a far greater reach than the usually small proportion of motivated 'volunteers' in individually based interventions (Saelens, Sallis, & Frank, 2003). Recent reviews in the physical activity and nutrition domain indeed show that environmental interventions have potential to positively influence EBRBs (De Bruijn, Kremers, Wendel-Vos, Van Lenthe, & Brug, 2005a; 2005b; Humpel, Owen, & Leslie, 2002; Kremers, De Bruijn, Droomers, Van Lenthe, & Brug, 2005c; 2005d). However, those interventions tend to be based on non-theoretical grounds (De Bruijn, Kremers, Wendel-Vos, Van Lenthe, & Brug, 2005; Kremers, De Bruijn, Droomers, Van Lenthe, & Brug, 2005c), rather than on theoretically based empirical findings. Whatever mechanism is involved in the direct and unmediated associations between environmental factors and EBRBs remains to be unraveled (for a starting point on these potential mechanisms; see final section in this chapter). The findings described in this thesis do indicate

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that social-cognitive factors are insufficient to account for these environmental influences.

Adoption of an energy balance approach

The findings reported in Chapter 8 provide initial cross-sectional evidence for the synergistic cognitive motivational mechanisms regarding clustered EBRBs, but, to date, many health promotion efforts have had a strong focus on changing single EBRBs. However, the advantages from adopting an energy balance approach (i.e. simultaneously focusing on energy intake and energy expenditure) may also translate to more effective interventions aiming to prevent weight gain for several reasons.

First, an increasing part of the population fails to adhere to several health-beneficial behaviors, rather than to a single behavior. Because social cognitions regarding several behaviors were found to cluster, a positive change in social cognitions regarding one behavior (for instance, a more positive attitude towards fruit consumption) may have some synergistic effects and induce a positive change in other behaviors, without the latter actually being targeted in an intervention.

Second, it allows participants in a weight-gain prevention program the possibility of choosing their preferred way of maintaining energy balance: some participants might be inclined to maintain energy balance by changing their way of transportation (e.g. walking instead of taking the bus) while others prefer minimizing their between-meal snacks. Offering a possibility for the target group to choose their most preferred EBRBs might be an attractive feature for intervention designers.

Interventions to prevent weight gain may benefit from considering personality influences

Although the small effect sizes found for the associations between personality and health behavior may suggest that personality is of little theoretical value (but see earlier section on theoretical implications), the practical value may nevertheless be relevant (Rhodes & Courneya, 2003b). Growing evidence shows that personality influences mortality (Friedman & Booth-Kewley, 1987; Friedman et al., 1993; Friedman et al., 1995; Smith, 1992). One probable mechanism for this influence is that personality may be related to health behavior. Generally, empirical evidence confirms this relationship (Booth-Kewley & Vickers, 1994; Caspi et al., 1997; Courneya, Bobick, & Schinke, 1999; Koppes, Twisk, Snel, De Vente, Kemper, 2001; Koppes, Snel, Kemper, 2004). For instance, in line with the findings reported in Chapter 7, Rhodes and Courneya (2003) and Courneya and colleagues (1999) found the personality dimension Extraversion to be of particular relevance in the prediction of exercise behavior. Likewise, two studies in this thesis showed

that higher levels Agreeableness was positively associated with soft drink consumption (Chapter 5) and vegetable consumption (Chapter 7), while higher levels of Openness to experience was positively associated with fruit and vegetable consumption (Chapter 7). Importantly, some of these associations were found even when behavior-specific cognitions were taken into account.

Furthermore, personality differences may have relevant implications for health educational campaigns. The four steps described in the aforementioned route to persuasion have been found to be influenced by personality differences (Cacioppo, Kao, Petty, & Rodriguez, 1986). In this study, attitude formation based on issue-relevance was stronger and more predictive for those who had a strong need for cognition, which may be related to Openness to Experience (Tuten & Bosnjak, 2001). Furthermore, increased attention is being given to the role of the Internet as a medium through which health-related information can be provided, either to the general public or as tailored advice (Kremers et al., 2005a; Kroeze, Werkman, & Brug, 2006; Oenema, Brug, & Lechner, 2001) and, again, evidence in the personality research field indicates that those with high levels of Emotional Stability and Openness to Experience are more likely to use the Internet for information (Tuten & Bosnjak, 2001). Consequently, personality differences may need to be taken into account when interventions are developed and tested, for instance by designing health campaigns and educational programs tailored to a personality structure rather than assuming that targeting social cognitions will subsume these personality differences (Caspi et al., 1997; Courneya, Bobick, Schinke, 1999; Rhodes, Courneya, & Jones, 2004; Vingerhoets, Croon, Jeninga, & Menges, 1990).

FUTURE PERSPECTIVES

Although research in the area of determinants of human health behavior is continuing at a rapid pace, questions have been raised regarding the true advances this research field has made in understanding why some people behave in a healthier fashion than others (Noar, 2005). One of the possible reasons for this lack of 'true advancement' may lie in the dominance of social-cognitive behavioral models in health behavior theory (Bargh & Chartrand, 1999; Jeffery, 2004; Ogden, 2003). These models center around the proposition that health behavior results from carrying out one's consciously planned intentions. While several additions to the TPB have been shown to increase our understanding of health behavior, these additional variables are, by and large, cognitive additions. However, as argued by Bargh and Chartrand (1999), "*most of a person's everyday life is determined not by their conscious intentions and deliberate choices but by mental processes that are put*

into motion by features of the environment and that operate outside of conscious awareness and guidance" (pp. 462). As a result of this and similar notions (e.g. Aarts, Verplanken, & Van Knippenberg, 1998), dual-process models are becoming increasingly popular in order to gain more insight in whether behavior results from automatic and unconscious processes or through conscious and deliberative reasoning (Ajzen, 2001; Bargh & Ferguson, 2000; Conner & Armitage, 1998; Eagly & Chaiken, 1993).

Deliberate guidance of behavior refers to the intra-individual factors that are accessible in one's awareness and operate consciously to evaluate environmental events, such as the social-cognitive factors outlined in the TPB. As discussed earlier in this thesis, these intra-individual factors are theorized to act as mediators in the environment-EBRB relationship. In contrast, guidance of behavior through automatic processes refers to behavioral responses that are directly set in motion by environmental stimuli. This perspective differs substantially from that of behaviorist theory. According to the latter, environmental events determine human behavior in a stimulus-response manner that does not acknowledge internal mediating constructs and processes (neither conscious or unconscious). Dual-process models advocate that the effect of environmental influences on behavior is thought to result from internal mental representations that are automatically activated by environmental cues to create behavioral tendencies without conscious choice or guidance (Aarts & Dijksterhuis, 2000; Bargh & Ferguson, 2000). These unconscious and effortless processes are thought to be essential in simplifying and understanding the information-rich environment (Bargh, 1999; Bruner 1957). A dual-process view may therefore provide both a theoretical and practical account of the mechanisms that may causally operate between environmental influences and EBRBs. Dual-process models, however, are not yet common in weight gain prevention research, although several recently proposed models for environmental influences on diet and/or physical activity have included implicit notions of such processes (Foster & Hillsdon, 2004; Glanz et al., 2005; Saelens, Sallis, & Frank, 2003; Spence & Lee, 2003). Based on inductive reasoning and empirical investigations, in which the studies presented in this thesis played a substantial role, Kremers and colleagues (2006) recently proposed the Environmental Research framework for weight Gain prevention (EnRG). This framework was developed as a starting point to gain insight into the causal mechanisms that underlie the environment-EBRBs relationship and is shown in Figure 12.

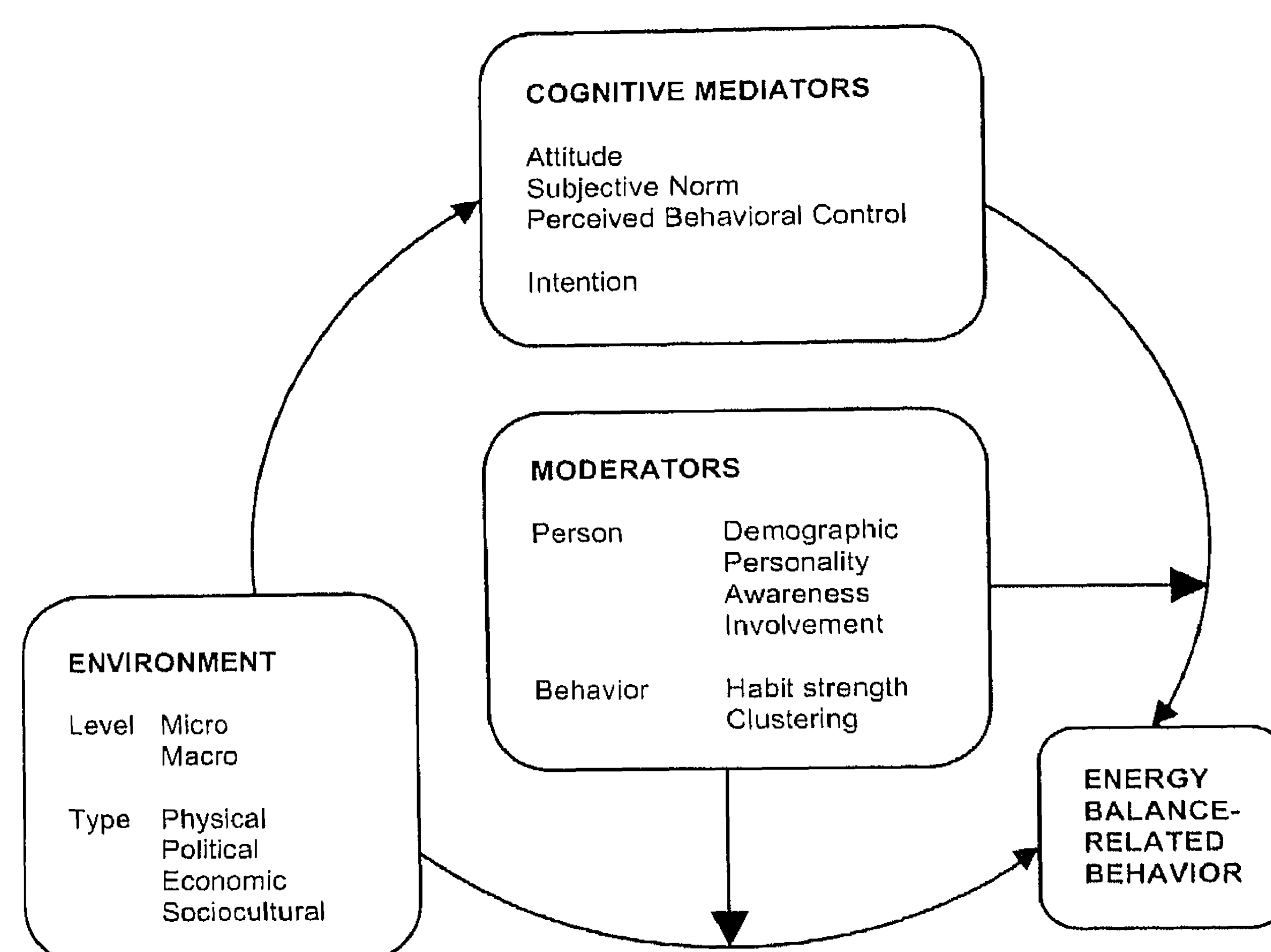


Figure 12. Environmental Research framework for weight Gain prevention

According to this framework, the direct and unmediated effect of degree of urbanization on adolescent bicycle use (Chapter 3) does not reflect methodological flaws (Ajzen & Fishbein, 2001), but may rather reflect the automatic activation of internal representations of goal-directed behavior (i.e. taking the bicycle as a travel mode to get to school). Empirical evidence corroborates this notion. For instance, in an experiment conducted amongst Dutch university students, Aarts and Dijksterhuis (2000) experimentally studied bicycle use choices in response to travel goals (e.g. having to go to university). In the experiment, the habitual transport mode (bicycle use) was either permitted or not. Furthermore, half of the participants were required to perform a cognitive load test (summing two digits). Their findings indicated a strong link between traveling to university and bicycle use, which was automatically activated upon being cued with the location 'university'. Additionally, this habitual response was to be more difficult to suppress than the non-habitual

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response. The direct effect of the influences from the social environment, such as parenting practices (Chapter 5) and social support (Chapter 6), on EBRBs may be explained in a similar manner. Studies have shown that social behaviors occur without intention (Carlston & Skowronski, 1994; Uleman, Newman & Moskowitz, 1996) and outside of one's awareness (Bargh, 2000). Thus, evidence justifies our provisional conclusions that both the perception of social support and parenting practices may influence EBRBs in the absence of conscious guidance. This contention seems to be supported by 'prompting' studies. Interventions aimed at increasing stair use have often applied a prompting strategy (Kremers, De Bruijn, Droomers, Van Lenthe, and Brug, 2005), in which respondents are 'prompted' to use the stair by using posters with short messages near elevators and/or stairs. These prompts appear to cue existing beliefs, without requiring substantial levels of attention or motivation, and support the notion that prompts serve as a 'peripheral cue' rather than a cue that involves central and conscious information processing.

In addition to the theoretical account of direct influence of environmental factors on EBRBs, the EnRG-framework also identifies the importance of moderator or so-called interaction variables. Because moderator effects are thought to be at the 'heart of theory' in science (Cohen et al., 2003; Hall & Rosenthal, 1991), several authors have called for the inclusion of interaction variables in behavioral research models (Aiken & West, 1991; Baranowski, Cullen, Nicklas, Thompson, & Baranowski, 2003; Baron & Kenny, 1986; Frazier et al., 2004; Holmbeck, 1997; Hoyle & Smith, 1994), but interaction analyses are relatively infrequent in the health behavior determinant literature (Sheeran, 2002) and intervention research (Kremers, De Bruijn, Droomers, Van Lenthe, and Brug, in press). According to Baron and Kenny's influential paper, a moderator variable is "*a qualitative (...) or quantitative (...) variable that affects the direction and/or strength of the relation between an independent or predictor variable and a dependent or criterion variable*" (pp.1174), which should preferably be theoretically derived (Baron & Kenny, 1986). In the EnRG-framework, specific personal and behavioral factors are postulated to act as moderators, namely (1) demographic factors, (2) personality, (3) awareness, (4) involvement, (5) habit strength, and (6) engagement in clustered behavior. Several studies reported in this thesis provide preliminary evidence of the usefulness for conducting moderator analyses. For instance, in line with Darling and Steinberg's theoretical model (Darling & Steinberg, 1993), Chapter 5 showed that the effect of parental house rules on adolescent soft drink consumption was moderated by adolescent personality. Additionally, Chapter 9 found that, in line with Triandis' (Triandis, 1977, 1980) reasoning, habit strength was a moderator of the intention-behavior relationship with regard to fruit consumption.

Also, the EnRG-framework acknowledges the importance of clustered behaviors and the potential importance of clustered cognitions. In addition to the findings reported in Chapter 8, Kremers, Van der Horst and Brug (in press) showed that screen-viewing and consumption of sugar-sweetened soft drinks in adolescents clustered with a medium effect size and habit strength related to these two behaviors was found to cluster with a large effect size. Importantly, the effect of parental house rules regarding screen-viewing behaviors was associated with consumption of sugar-sweetened soft drinks, even after adjusting for parental house rules and cognitions related to sugar-sweetened soft drink consumption. Such findings are illustrative of the potential of an energy-balance approach in designing more effective weight-gain prevention interventions. For instance, interventions aimed at decreased screen-viewing behaviors through parental house rules may additionally lead to decreased soft drink consumption, without the latter behavior actually being targeted in the intervention.

Rather than focusing on *which* factors may be important, the EnRG-framework is specifically directed at generating questions related to *when*, *how*, and *for whom* environmental factors may be influential. For instance, the availability of fruit at home will have a direct association with fruit consumption for those who have a strong habit towards fruit consumption, but a cognitively mediated association for those whose fruit consumption is not habitual (see also Chapter 9). Likewise, parental home rules regarding television-viewing or soft drink consumption will have a direct impact on adolescents, depending on their level of Agreeableness (see Chapter 5) or their willingness to comply with these rules (Kremers, De Bruijn, Van der Horst, and Brug, submitted). Additionally, and as suggested elsewhere (Poulton & Caspi, 2003; Pulki, et al., 2003), personality influences may moderate the influences of socio-economic position and neighborhood deprivation on health behaviors, such as those found in Chapter 2.

Although this framework has been commended as an excellent first step (Ball, Timperio, & Crawford, 2006) and the indications derived from the studies conducted in this thesis provide provisional evidence for the usefulness of the dual-process perspective (as outlined in the EnRG framework) for explaining both the mediated and unmediated effects of environmental influences on EBRBs, as well as the interactive effects regarding these relations, future research is clearly needed to demonstrate its surplus value of traditional health behavior models. In fact, the framework is the result of an inductive reasoning process, and deductive reasoning (i.e. moving from a general framework to specific observations) is now needed to narrow down the framework to testable hypotheses. Inductive and deductive theorizing should be better appreciated as a means to knowledge

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acquisition in theoretical development (Epstein, 1998) and the most desirable goal is not the validation of the framework in its present form, but rather should be viewed in the evolution of a paradigm. Although paradigms are limited in precision when they first appear, major advances in a field are often based on a paradigm shift (Kuhn, 1962).

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Summary

Overweight and obesity prevalence rates have increased dramatically in the past few decades in virtually all age groups in the Western world. Treatment of overweight and obesity has proven problematical, i.e. people often tend to regain weight after treatment has ended. Therefore, a stronger focus on the prevention of overweight and obesity is needed. Because the genetic pool of humans has not changed in the last thousand years, the current obesity epidemic is largely related to behavioral factors that exert pressure towards a positive energy balance. A positive energy balance occurs when caloric intake exceeds caloric expenditure over a given period of time. Several energy balance-related behaviors have been identified, including weight-gain inducing behaviors such as physical inactivity and soft drink consumption, but also weight-gain preventive behaviors such as fiber consumption and regular physical activity. Most interventions aimed at preventing weight gain have been based on psychosocial determinants, which are often derived from the Theory of Planned Behavior. This theory acknowledges intention as the primary determinant of behavior. That is, people are likely to perform behaviors they intend to perform. Intention is determined by attitude, subjective norm, and perceived behavioral control. Traditional health behavior interventions have targeted these determinants mainly through mass media campaigns, which aim to increase awareness and motivation towards a particular behavior using educational and informational strategies. However, such campaigns have had limited long-term success in changing these behaviors. It has been argued on several occasions that the environment people live in nowadays does not support enduring behavioral change after exposure to the intervention is over. Indeed, an obesogenic environment, i.e. an environment that stimulates physical inactivity and the consumption of energy-dense foods, is acknowledged as a important cause of the current obesity epidemic. Because more effective weight-gain prevention interventions are likely to be developed if the relative associations of environmental-level and individual-level factors are identified, this thesis attempts to add to the current knowledge on obesity prevention research by exploring and modeling relevant environmental-level and individual-level factors with several behaviors known to be important to the energy balance. Furthermore, because several concerns have been raised about the usefulness of the Theory of Planned Behavior, this thesis also explored several potentially relevant individual-level additions that may further our understanding of the determinants of energy balance-related behaviors.

Physical environmental factors

The first part of this thesis investigated factors related to the physical environment. In

Chapter 2, we initially explored the association between neighborhood socio-economic status and odds for obesity in a Dutch elderly population, as well as investigating differences in specific environmental factors (i.e. crime rates and household density) between low and high socio-economic status neighborhoods. We then explored whether walking and bicycling acted as mediators in the relationship between these specific environmental factors and BMI. Results showed that, among men, residing in a low socio-economic status neighborhood was associated with an significantly increased chance of being obese. Furthermore, low socio-economic status neighborhoods had significantly higher household density and higher crime rates, which were both significantly and positively associated with BMI. The final analysis showed that, among men residing in low socio-economic status neighborhoods, the effect of crime rates on BMI was partially mediated by bicycling, but not by walking. It was concluded that differences in obesity prevalence rates between low and high socio-economic status neighborhoods are partially attributable to differences in crime rates within these neighborhoods, which in turn are directly and indirectly associated with BMI among elderly men.

To explore the mediating role of behavior-specific cognitions in the physical environment-bicycle use relationship, Chapter 2 focused on, amongst other potential determinants, the association between degree of urbanization and bicycle use for transportation among adolescents. Adolescents who attended school in a less-urbanized town were almost twice as likely to use their bicycle for transportation purposes, even after controlling for bicycle use-related cognitions, suggesting a direct effect environmental factors may have on energy balance-related behaviors.

Using a structural equation modeling approach, Chapter 4 then investigated associations between neighborhood aesthetics, proximity to local facilities, distance to opportunities for physical activity, and TPB-cognitions related to physical activity with adolescent past and current physical activity. Results showed that neighborhood aesthetics was significantly and positively associated with attitude towards physical activity, whereas distance to physical activity opportunities was significantly and positively associated with perceived behavioral control and attitude towards physical activity. In turn, perceived behavioral control was significantly and positively associated with physical activity. Past physical activity was the strongest correlate of current physical activity. It was concluded that the statistical modeling of relevant environmental-level and individual-level factors using theoretical relations may be an important step towards exploring their relative influences on physical activity.

Social environmental factors

Because the home environment is considered to be one of the most important settings related to children's eating and physical activity behaviors, Chapter 5 investigated the effect of parental house-rules with regard to soft drink consumption and adolescent's consumption of these soft drinks. In addition, Chapter 5 explored the hypothesized mediating role of TPB-cognitions related to soft drink consumption. Intention towards limited soft drink consumption was not significantly associated with actual soft drink consumption, whereas parental house-rules had a direct and largely unmediated relation with soft drink consumption; adolescents who perceived stronger house-rules towards limited soft drink consumption drank less soft drink. Importantly, adolescent personality was found to moderate the association between parental house-rules and adolescent soft drink consumption. More specifically, the association of parental house-rules with soft drink consumption was strongest amongst adolescents who had medium levels of Agreeableness, providing preliminary evidence for a person*environment interaction.

In Chapter 6, the focus was on social support and adult moderate and vigorous physical activity. Previous findings have consistently indicated a positive relationship between social support and physical activity in various populations. Nevertheless, the sources and types of social support are rarely, if ever, differentiated. Furthermore, this evidence tends to be based on physical activity of vigorous intensity. To add to the current knowledge on physical activity and social support, Chapter 6 modeled the associations between several sources and types of social support with adult moderate and vigorous physical activity. Encouragement, instrumental, informational, and emotional social support were used as types of social support, while family members and friends were used as the two sources of social support. In addition, the mediating effect of self-efficacy concepts in the social support - physical activity relationship was investigated. Using a structural equation modeling approach, our analyses showed that different sources and types of social support were associated with different intensity levels of physical activity. In addition, self-efficacy concepts partially mediated the association between social support and vigorous physical activity. In contrast, self-efficacy did not mediate the association between social support and moderate vigorous physical activity. It was concluded that different sources and types of social support are associated with different intensity levels of physical activity and that the importance of self-efficacy appears to increase with the intensity level of physical activity.

Potentially relevant individual-level factors

In the final part of this thesis, several potentially relevant additional individual-level factors were explored. In Chapter 7, associations between Big Five personality dimensions and adolescent physical activity and fruit and vegetable consumption are reported. In line with findings from (young) adult samples, more extraverted adolescents engaged in more sports-related physical activity. In line with our hypotheses, more Agreeable adolescents consumed more vegetables but, countering findings from (young) adult samples, Conscientiousness was not significantly associated with any of the health behaviors under study. Positive associations between Openness to Experience and fruit and vegetable consumption were also observed. It was concluded that Big Five personality dimensions are a potentially relevant individual-level determinant of adolescents' energy balance-related behaviors.

In Chapter 8, findings regarding the clustering effect of several energy balance-related behaviors and their respective TPB-cognitions are described. Our findings showed that fruit consumption was positively associated with physical activity in leisure time, whereas snacking behavior was positively associated with the use of high-fat sandwich filling. Small effect sizes were found for the clustering of energy balance-related behaviors, while medium to large effect sizes were found for the clustering of social-cognitive constructs.

Finally, Chapter 9 investigated differences in fruit consumption across three levels of habit strength with regard to fruit consumption, while also testing the potential moderating effect of habit in the intention-behavior relationship. Results showed that more fruit was consumed by those who had a strong habit for fruit consumption, yet half of this latter group habitually consumed less than the recommended two pieces of fruit per day. Using multi-group structural equation modeling, Chapter 9 also showed that habit was a moderator of the intention-behavior relationship. For those with low and medium habit strength for fruit consumption, intention was a significant predictor of fruit consumption five weeks later. In contrast, for those with a strong habit towards fruit consumption, intention did not significantly predicted fruit consumption five weeks later. It was concluded that habit may play an important role in determining energy balance-related behaviors, while implications for information-based interventions were suggested.

Practical and theoretical implications of the studies described above are outlined in Chapter 10. It is concluded that environmental factors may play an important part in determining energy balance-related behaviors. A dual-process model is postulated to account for the direct associations of physical and social environmental factors with energy

balance-related behaviors. Furthermore, this model also acknowledges potential factors that may moderate the association of environmental and individual factors with energy balance-related behaviors.

SAMENVATTING

Prevalentiecijfers van overgewicht en obesitas zijn de laatste decennia rap toegenomen in de Westerse wereld. Omdat behandeling van overgewicht en obesitas vaak kortdurende effecten oplevert, gaan tegenwoordig steeds meer stemmen op om overgewicht en obesitas te voorkomen. Aangezien de genetische opmaak van mensen de laatste duizenden jaren niet is gewijzigd, is de huidige obesitas epidemie zeer waarschijnlijk toe te wijzen aan een veranderde levensstijl die leidt tot een positieve energie balans. Een positieve energie balans houdt in dat men meer calorieën tot zich neemt (door middel van voedselname) dan men verbrandt (met name door lichamelijke activiteit). Met andere woorden: de obesitas epidemie is grotendeels toe te schrijven aan gedragsfactoren die deze energie balans verstoren. Om succesvolle interventies te ontwikkelen, is het noodzakelijk kennis te hebben van de determinanten van deze 'energie balans-gerelateerde gedragingen'. Deze determinanten worden traditioneel geleverd door sociaal-cognitive gedrags theorieën. Een van de meest gebruikte theorieën is de Theorie van Gepland Gedrag. Deze theorie gaat uit van het feit dat intentie de belangrijkste determinant is van gedrag. Intentie wordt zelf bepaald door de attitude, de subjectieve norm en de waargenomen gedragscontrole ten aanzien van het gedrag. Veel gedragsinterventies trachten door middel van voorlichtingsstrategieën mensen bewust te maken van het gewenste gedrag en een positieve intentie te bewerkstelligen om gezond gedrag te vertonen. Dergelijke educatieve strategieën hebben echter zelden langdurig effect. Een van de redenen hiervoor is dat de fysieke en sociale omgeving waarin men leeft het oorspronkelijke ongezonde gedrag weer aanwakkert als de interventie voorbij is. Het belang van een obesogene omgeving (een omgeving die inactiviteit en consumptie van hoog calorische voeding stimuleert) voor de obesitas epidemie is reeds verscheidene malen aangekaart. Omdat mogelijk effectievere interventies ontwikkeld kunnen worden als de relatieve invloed van persoonlijke en omgevingsdeterminanten van energie balans-gerelateerde gedragingen bekend zijn, heeft dit proefschrift getracht relevante persoonlijke en omgevingsfactoren te modelleren met enkele energie balans-gerelateerde gedragingen. Verder trachtte dit proefschrift enkele mogelijke relevante additionele persoonlijke determinanten van energie balans-gerelateerd gedrag te onderzoeken.

Fysieke omgevingsfactoren

In het eerste deel van dit proefschrift was de focus op fysieke omgevingsfactoren. Hoofdstuk 2 onderzoekt de associatie tussen sociaal-economische status van de buurt met

de kans op obesitas onder ouderen. Daarnaast werden verschillen in misdaadcijfers en omgevingsadressendichtheid tussen laag en hoog sociaal-economische status buurten onderzocht. Verder werd onderzocht of wandelen en fietsen de relatie van misdaadcijfers en omgevingsadressendichtheid met BMI medieerden. Uit de analyses bleek dat er in buurten met een lage sociaal-economische status meer misdaad gerapporteerd werd en dat de adressendichtheid significant groter was dan in buurten met een hoge sociaal-economische status. Verder bleek dat mannen die in een laag sociaal-economische buurt woonden een significant grotere kans hadden om obese te zijn dan mannen die in een hoog sociaal-economische buurt woonden. Mannen uit buurten met een lage sociaal-economische status fietsen significant minder dan mannen uit buurten met een hoge sociaal-economische status. Dit fietsgedrag was onder deze mannen significant gerelateerd aan BMI, maar fietsgedrag was slechts ten dele in staat om de invloed van misdaadcijfers op BMI te mediëren. Geconcludeerd werd dat sociaal-economische buurt verschillen in obesitas gedeeltelijk herleid kunnen worden tot verschillen in misdaadcijfers tussen deze buurten, die zowel direct als indirect gerelateerd zijn aan fietsgedrag onder oudere mannen.

In Hoofdstuk 3 werd de mediërende rol van gedragsspecifieke cognities getoetst in de relatie tussen fysieke omgevingsfactoren (in dit geval urbanisatiegraad) en fietsgedrag van adolescenten. Uit de resultaten bleek dat urbanisatiegraad significant geassocieerd was met fietsgedrag: adolescenten die naar school gingen in de stad met een hoge urbanisatiegraad hadden een kleinere kans om de fiets te nemen als actief transportkeuze. Deze associatie bleef bestaan toen werd gecorrigeerd voor cognities gerelateerd aan fietsgedrag, wat suggereert dat de omgeving energie balans-gerelateerd gedrag kan beïnvloeden zonder tussenkomst van gedragsspecifieke cognities.

In Hoofdstuk 4 werd een Structural Equation Model getoetst dat de relatieve invloed onderzocht van de aantrekkelijkheid van de buurt, nabijheid van faciliteiten om lichamelijke actief te zijn, en afstand in meters tot dichtstbijzijnde plek om actief te zijn met gedragsspecifieke cognities en lichamelijke activiteit. Aantrekkelijkheid van de buurt was significant gerelateerd aan de attitude om lichamelijk actief te zijn, terwijl de afstand tot de dichtstbijzijnde plek significant gerelateerd was aan attitude en waargenomen gedragscontrole met betrekking tot lichamelijke activiteit. Waargenomen gedragscontrole was significant gerelateerd aan lichamelijke activiteit, terwijl het sterkste verband werd gevonden tussen huidige en vroegere lichamelijke activiteit. Er werd geconcludeerd dat het statistisch en theoretisch modelleren van relevante omgevingsfactoren en persoonlijke factoren met lichamelijke activiteit een belangrijke stap kan zijn om de relatieve invloed

van omgevingsfactoren en persoonlijke factoren te onderzoeken.

Sociale omgevingsfactoren

Omdat de thuisomgeving een van de belangrijkste factoren is voor het eet- en beweeggedrag van kinderen en adolescenten, werd in Hoofdstuk 5 de associatie onderzocht tussen ouderlijke regels ten aanzien van frisdrankconsumptie en de daadwerkelijke consumptie van deze frisdranken door adolescenten. Verder werd onderzocht of deze associatie werd gemedieerd door gedragsspecifieke cognities. Resultaten lieten zien dat kinderen die meer ouderlijke regels ten aanzien van frisdrankconsumptie rapporteerden minder frisdrank dronken. Dit effect werd nauwelijks gemedieerd door gedragsspecifieke cognities. Belangrijk was ook dat de positieve relatie tussen ouderlijke regels en frisdrankconsumptie van adolescenten werd gemodereerd door de persoonlijkheid van de adolescent. Hiermee werd onderbouwing gevonden voor een persoon-omgeving interactie.

In Hoofdstuk 6 werd een studie beschreven die zich richtte op sociale steun, eigen effectiviteit en matig-intensieve en hoog-intensieve lichamelijke activiteit onder volwassenen. Ofschoon vele studies reeds een positief verband hebben aangetoond tussen sociale steun en lichamelijke activiteit, werd er in deze eerdere studies zelden onderscheid gemaakt tussen verschillende typen sociale steun en verschillende bronnen van sociale steun. Daarnaast hebben deze studies zich veelal gericht op hoog-intensieve lichamelijke activiteit. Door middel van Structural Equation Modeling werd onderzocht of de associaties tussen sociale steun en lichamelijke activiteit verschilden tussen matig-intensieve en hoog-intensieve lichamelijke activiteit. Verder werd onderzocht of eigen effectiviteit een mediërende rol speelde in deze associatie. Uit de analyses kwam naar voren dat de typen en bronnen van sociale steun verschilden tussen de twee intensiteitsniveaus van lichamelijke activiteit. Eigen effectiviteit medieerde de invloed van sociale steun op hoog-intensieve lichamelijke activiteit slechts gedeeltelijk, terwijl de relatie tussen sociale steun op matig-intensieve activiteit niet werd gemedieerd door eigen effectiviteit. Er werd geconcludeerd dat verschillende types en soorten sociale steun van belang zijn bij verschillende intensiteitsniveaus van lichamelijke activiteit en dat het belang van eigen effectiviteit toeneemt met het intensiteitsniveau van lichamelijke activiteit.

Additionele persoonlijke determinanten

In het laatste deel van dit proefschrift werden potentieel relevante additionele persoonlijke determinanten onderzocht. In Hoofdstuk 7 werden associaties tussen Big Five persoonlijkheidsdimensies en groenten-en fruitconsumptie en lichamelijke activiteit beschreven.

Net als de bevindingen uit studies onder (jong)-volwassenen, werden positieve associaties gevonden tussen Extraversie en lichamelijke activiteit. Verder werd, conform de hypothese, een positieve relatie gevonden tussen Aardigheid en fruitconsumptie. Echter, in tegenstelling tot bevindingen onder (jong)-volwassenen, was Nauwgezetheid niet significant gerelateerd aan lichamelijke activiteit en groenten-en fruitconsumptie. Daarnaast werden positieve associaties gevonden tussen Vindingrijkheid en groenten-en fruitconsumptie. Geconcludeerd werd dat persoonlijkheidsdimensies een potentieel relevante persoonlijke determinant is van energie balans-gerelateerd gedrag onder adolescenten.

In Hoofdstuk 8 werden de resultaten beschreven van een studie waarin het clustering effect van energie balans-gerelateerde gedragingen en de gedragsspecifieke cognitieve factoren werd onderzocht. Uit de analyses bleek dat fruit consumptie positief gerelateerd was aan lichamelijke activiteit in de vrije tijd, terwijl snackconsumptie positief geassocieerd was met consumptie van vet broodbeleg. Meer en sterkere clustering effecten werden gevonden voor de gedragsspecifieke cognities.

In het laatste hoofdstuk van dit deel werden verschillen in fruitconsumptie onderzocht over drie groepen van gewoontesterkte ten aanzien van fruitconsumptie. Verder werd de modererende rol van gewoonte in de intentie-gedagsrelatie onderzocht. Resultaten toonden aan dat mensen die een sterke gewoonte hadden ten aanzien van fruitconsumptie significant meer fruit aten dan mensen met een lage gewoontesterkte. Echter, onder de mensen met een sterke gewoonte at slechts de helft de aanbevolen hoeveelheid van twee stuks fruit per dag. Uit de multi-group structural equation modeling bleek dat intentie een significante voorspeller was voor fruit consumptie vijf weken later voor diegenen met een lage en middelmatige gewoontesterkte. Daarentegen was intentie een zwakke en niet-significante voorspeller voor diegenen met een sterke gewoonte voor fruitconsumptie. Geconcludeerd werd dat gewoonte een belangrijke rol kan spelen in energie balans-gerelateerd gedrag, waarna implicaties voor informationele interventies werden gesuggereerd.

Theoretisch en praktische implicaties van bovengenoemde studies werden beschreven in Hoofdstuk 10. Uit de resultaten van de uitgevoerde studies werd geconcludeerd dat fysieke en sociale omgevingsfactoren mogelijk belangrijke directe determinanten zijn van energie balans-gerelateerd gedrag. Een dual-proces model werd gepostuleerd als een verklarend framework voor de directe relatie tussen omgevingsfactoren en energie balans-gerelateerd gedrag. Daarnaast werd in dit model een aantal potentiële moderatoren aangeduid in de relatie tussen de omgeving en energie balans-gerelateerd gedrag.

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Het schrijven van dit boekje was niet mogelijk geweest zonder de hulp van een hoop mensen. Hans, ondanks dat je kort na mijn aankomst in Maastricht zelf naar Rotterdam vertrok, heb ik bijzonder veel aan je gehad. Het is erg motiverend om samen te werken met iemand met jouw energie en onaflatende werklust. Stuurde ik je een draft voor een artikel, dan lag veelal binnen twee dagen jouw commentaar in mijn mailbox. Bedankt ook voor het vertrouwen dat je me gaf door me naar het ErasmusMC te halen. Je opmerking die je tegen mij maakte tijdens een ZonMW-review lunch "als er iemand zijn eigen plan trekt, ben jij het wel" heb ik als een mooi compliment ervaren. Ik hoop nog lang met je te mogen samenwerken. Overigens, jouw proefschrift had meer hoofdstukken, de mijne meer pagina's...

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One more thing...

*Mozart, of mijn ontmoeting
met de zaligheid*

E.M. Cioran

Gert-Jan de Bruijn was born on May 21st 1973 in the Dutch town of Breda. At birth, he weighed 3,120 kgs and measured 48 cms, suggesting a healthy birth weight. After attending elementary and secondary education, he started studying Psychology at Utrecht University in 1996 from which he graduated in January 2002. In June 2002, he started working as a PhD-student at the Department of Health Education and Health Promotion at Maastricht University. From July 2006 until January 2007, he worked as a post-doctoral researcher at the Department of Public Health at the Erasmus Medical Center in Rotterdam, The Netherlands. As of Februari 1st 2007, he is working as an assistant professor at the Amsterdam School of Communication Research at the University of Amsterdam.

In June 2002, he weighed 75 kg and measured 1.78 m, indicating a normal BMI. Both in July 2006 and January 2007 he weighed 71.5 kg, suggesting that both the physical and social environment during the PhD-student period and post-doctoral research period are non-obesogenic and, consequently, non-critical periods for weight gain. However, because personality influences may moderate the influence of these environments (among other potential moderators, see Page 178), additional research using larger and more diverse samples is nevertheless required to substantiate these conclusions. Furthermore, future research may need to investigate whether these findings are transferable to assistant professor jobs.